HANDICRAFT FOR HANDY PEOPLE

PLAIN INSTRUCTIONS

ON

CHOICE & USE OF TOOLS,
CARPENTRY,
LOCKS AND HINGES,
HOUSEPAINTING,
STAINING,
VARNISHING,
DISTEMPERING,
PAPER HANGING,
GLAZING,
PICTURE FRAMING,
SOLDERING & METAL WORK,
GILDING,
FILTERS,
MAP MOUNTING,
CEMENTING,
THE GRAPH,
&c. &c.

WITH 75 ILLUSTRATIONS

BY

AN AMATEUR MECHANIC.

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PREFACE.

The subject of Technical and Industrial Education has of late engaged much attention. Some few years ago a Royal Commission on Technical Instruction was issued, the members of which made careful inquiries regarding the steps taken in these and other countries to educate the working classes, so as to fit them for their various handicrafts; and the Commissioners have lately issued their Second Report, full of most valuable and interesting information. The Science and Art Department holds Technological examinations every year; there are books and lectures on technical subjects for workmen; technical schools have been opened; and scarcely a year passes without an exhibition of handicraft work in some part of the kingdom.

The people of Ireland seem resolved not to be left behind; and the earnest interest taken in the matter by those most concerned is shown by what is now occurring in Dublin. For during the present summer we are to have an Artisans' Exhibition, the expenses of which are chiefly borne by the working men and their employers; and as it is receiving the hearty support of all classes, it promises to be a great success.

All this active interest in Technical Education is the result of manufacturing competition; for people will buy the best articles no matter where or by whom produced. It is now felt that the competition among nations is not so much a competition of muscular strength or of mere manual dexterity, as of mind and intelligence; and that the country whose working men are best educated and most intelligent in their several crafts, will produce the best articles, and will command the markets of the world.

The surest way to spread Technical Education among the people is to begin in the homes and in the schools. Then the work may be said to go on simultaneously at both ends. For, on the one hand, whilst efforts are made, both by the government and by associations of the great employers and others, to diffuse sound information on technical and industrial subjects; on the other hand, the working people, having already acquired some technical intelligence and a taste for mechanical occupations, are all the more willing and able to take advantage of the opportunities held out to them from above.

That this is the belief of those having the best opportunities for forming a judgment on the matter, is shown by the recent action of the Board of National Education in Ireland. When the Resident Commissioner, Sir Patrick J. Keenan, K.C.M.G., C.B., was examined two years ago by the Royal Commissioners on Technical Instruction, he gave the following evidence:—

(Question 5869).—I believe I am right in the supposition that you consider there is an intimate connection between the

ordinary instruction given in schools and technical education? I think technical instruction should be part of the ordinary education given to a child in his school course.

(5870). Do you think such instruction desirable for those who will not have in after life to follow manual occupations? I do. I consider it desirable that everybody, from the peer to the peasant, should be taught while at school to be "handy," so as to be able in after life to turn to account any little training he receives in childhood.

(5871). Such instruction is of course especially valuable for those who have to gain their livelihood by manual labour? Certainly. It is especially valuable to that class.

(5874). You are of opinion also, I believe, that it would be useful to teach the use of tools in all elementary schools? I have a strong expectation that we shall in the course of a few years be able to take a step in that direction in all our ordinary schools through the country. When those young men of the training college, whom you saw here at work, return to their respective schools, able, as I hope they will be, to impart to the classes under their care the instruction they have received here, we intend to devise a scheme of results fees payable for proficiency in the use of tools.

Again in answer to question 5884.

I hold it that every boy ought to be taught to be handy. If he has been taught to be a thorough master of his fingers, hands, and eyes, then, no matter what he turns to in after life, whether he is a labourer, a tradesman, or engaged in any higher occupation, that early training will be of service to him.

(5889). As I understand, you do not intend to teach trades? No: you have in your question exactly represented what is passing in my mind, that any attempt in an ordinary day school to teach boys a particular trade would neither be practicable nor desirable, but that the object should be to train them, for instance, in lineal drawing, and in such

practices of "handiness," that when they become apprentices to trades, whether carpenters, bricklayers, or stonemasons, &c., they will be sure to learn their trades with comparative ease, and become successful in them afterwards. If we do that I think our function is properly fulfilled.

The statements and opinions here set forth are embodied in a recent decision of the National Board, to make Handicraft an Extra Subject for which results fees will be paid to the teachers. And in the latest edition of the Board's published Rules, a detailed Programme is given, in which masters who wish to open classes in Handicraft must pass examination, in order to be entitled to teach and earn results fees in this very important subject. The Programme will be found in the Appendix at the end of this book.

In respect to manual work, men differ greatly. Some are quite at home with tools, and no sooner has anything gone wrong in or about the homestead than it is examined and set right. To such persons handicraft work is a useful recreation and a pleasure. Others are so helpless that they can hardly be said to have the use of their hands at all; and for the least thing that goes wrong they are at the mercy of outsiders. Yet this helplessness does not arise from any natural incapacity; for undoubtedly, every person, whether young or old, can learn to use his hands if he only tries.

This book is intended to be a guide and a help to those who wish to improve themselves in practical Handicraft; and I venture to express a hope that

it will meet the wants of National and other Schools in which Handicraft classes are opened.

I have endeavoured throughout:—

To avoid all mere talk and useless disquisitions; to make every sentence go straight for the subject in hand; and in every way to economise space, so as to compress as much matter as possible within the covers of a small book.

To make the instructions so plain and simple as to be easily understood by anyone, young or old, who can read them: and lastly,

To make the several articles exhaustive, so far as was necessary for the object in view; so that by following out the instructions, any person of ordinary wit and handiness should be able to practise successfully any one of the Handicrafts here treated of, even though he had never tried it before. To this end, besides the ordinary instructions, every information that might by any chance be needed is supplied:—all the articles mentioned, whether tools or materials, are described; the prices are invariably given; and the reader is told how and where to get them.

The prices given here are those charged in large establishments in Dublin: in small shops in country towns the several articles will probably cost something more.

In connexion with this, it is well to know that tools or materials of any kind will be sent from the

large shops in towns by the parcels post to any part of the three kingdoms, the cost of transit being only a few pence; so that persons living in remote places, far from towns, can order and get things in this way through the post office.

Every writer of a book like this supplements the knowledge derived from his own experience by the experience of others. I have consulted many books with advantage, of which I think it necessary to mention only the following:—Spon's "Mechanic's Own Book:" Spon's "Workshop Receipts;" "Every Man his own Mechanic;" and the well-known periodical, "Amateur Work Illustrated." These works abound in information on every subject they treat of, and I thankfully acknowledge my obligations to them all. Some of the illustrations—those containing the human figure and a few others—have been taken from an American publication, "How to use Wood-working Tools," an admirable little book, both in matter and illustrations, though very limited in scope.

Dublin, May, 1885.

CONTENTS.

HANDICRAFT

FOR

HANDY PEOPLE.

CHAPTER I.

TIMBER.

Soft and Hard Woods.—Workmen distinguish woods as either hard or soft. Pine and deal of all kinds are soft, and they are almost the only soft woods the amateur will have to do with. Beech, oak, ash, mahogany, elm, &c., are hard woods. Horse chestnut, sycamore, black walnut, &c., are medium—neither so soft as pine, nor so hard as beech.

Different kinds of Timber.—It may be useful to give here a short description of the kinds of timber in most common use.

Ash.—The wood of the ash is close-grained, elastic, and tough; and as it bears bending well it is often used for curved work. It answers well for the handles of spades, shovels, hammers, and such like.

Beech.—The grain is fine and straight, and suitable for carving. It is used for the wood part of many tools, such as planes, saws, &c., and it serves well for small machine-wheels that are to be cut in cogs.

Birch.—The wood is white, firm, and tough, and

may be used for a great variety of purposes, such as wheels, and for various articles made by turners.

Box.—The box-tree seldom grows large in these countries, so that the wood is generally imported from Turkey and other southern countries. It is exceedingly dense and heavy, very hard, compact, and even in grain, of a pale yellow colour, and capable of taking a fine polish. It is used by turners and wood-carvers; and for making mathematical and musical instruments, and many small articles, such as chessmen. It takes a fine polish, and may be stained to imitate ebony.

Chestnut.—The wood of the Spanish chestnut is hard and durable, and often beautifully variegated in grain: it is sometimes used for furniture. The horse chestnut is quite a different tree: the wood is white and brittle, and is used for toys and fancy goods.

Deal or Pinewood.—There are many species of pinewood or deal, but it will not be necessary to describe them minutely. The common white deal is used for many kinds of ordinary work. There are several superior kinds, such as red and yellow deal, and pitch pine, which are used for finer kinds of work, and are much more expensive than white deal. They are straight-grained, generally free from knots, soft and easily worked, and very durable. White deal, on the other hand, is harder than the others, not so straight-grained, not so durable, and generally has many knots.

Elm.—The wood of the elm is tough, cross-grained, and hard to work; it is very difficult to split, so that it is used where there is much splitting strain, as for wheels, &c. It is extremely durable, and will stand immersion in wet clay, and in moist places of every kind, for a very long time; and for this reason it was formerly, and in many places is still often used for water pipes.

Mahogany.—An ornamental wood, with which the amateur will not have much to do. It is used for

furniture, veneering, and for many ornamental purposes: it takes a very fine polish, and holds glue better than almost any other wood.

Oak.—This wood is hard and durable, and though not close in texture, takes a fine polish. It is hard to work and soon takes the edge off tools.

Sycamore.—Wood white, moderately soft, and easily worked: used for carving and for making models.

Walnut.—The wood is close in grain, takes a fine polish, and is beautifully variegated: used in making furniture, pianos, gun-stocks, &c.

Seasoning of timber.—Timber should be seasoned before being used: otherwise it will shrink or warp after the work is finished. If any work is to be done which would be injured or disfigured by shrinkage, the timber should be bought some time beforehand and left *standing* (not lying) in the open air, the several pieces separate, to expose them to the air as much as possible.

Strength of timber.—Suppose pieces of timber, all of equal length, laid horizontally and supported at the ends; then their strength, that is to say, their power to support weights placed in the middle, is in direct proportion to the breadth and to the square of the depth.

Take the breadth first: there are two pieces equal in depth, and one twice as wide as the other: then the wider one is twice as strong as the other.

Next take the depth: there are two pieces equal in width and one twice as deep as the other: then the deeper one is *four times* as strong as the other.

Now take breadth and depth combined: there are two pieces, of which the first is 8 inches deep and 5 inches wide, and the second 6 inches deep and 4 inches wide. Then the supporting strength of the first is to that of the second as $8^2 \times 5$ is to $6^2 \times 4$, or as 320 is to 144.

From this it appears that a piece of timber like a

joist is stronger when laid edgewise than when laid flat. Suppose the piece is 6 inches broad and 2 inches thick: then its strength when placed edgewise (as a joist) is to its strength when placed flat as $6^2 \times 2$ is to $2^2 \times 6$, or as 72 is to 24: in other words it is three times stronger.

If a piece of timber, whether placed horizontally or vertically, be exposed to any strain across its length—as for instance the pole of a clothes line; place it so that the greater dimension shall be in the direction of the strain.

The strength of beams is inversely proportional to the lengths. Thus if two beams have the same depth and breadth, and one is twice as long as the other; the long one will have only half the strength of the other.

How timber is sold.—As pine or deal is the timber in most common use, it will be useful to say something about the way in which it is sold, and the prices.

White deal is used for most of the ordinary kinds of work—gates, posts, railings, shelves, common doors, flooring, sheeting, &c. Red, yellow, and pitch pine are used for works of a better, more durable, or finer character—window-sashes, best house-roofing, the finer kinds of doors, &c.

The usual widths of timber, as it is sold in the timber yards, are 7, 9, and 11 inches; and the usual thickness is 3 inches. It is sold of all lengths down to 6 feet; the most usual length being 12 feet. But pieces or boards of any length, breadth, or thickness may be bought—of course within reasonable limits. Three-inch or $2\frac{1}{2}$-inch pieces 7 inches wide are called *battens:* 9-inch-wide pieces—same thickness—are called *deals:* and 11-inch-wide pieces, *planks.*

The ordinary price of a good white deal, 12 feet long, 9 inches wide, and 3 inches thick, is 3s. The prices of pieces of other lengths, breadths, or thicknesses, can be easily calculated, as they are in proportion to the quantities, or the solid contents.

The better kinds of pine—yellow, red, and pitch—vary somewhat in price among themselves: but it will be enough to state here that they are nearly double the price of white deal.

The planks and deals are sawed into boards and planed by machinery in the large timber yards: and the boards that are cut from a deal will cost very little more than the solid deal itself. Thus if the 3s. deal mentioned above be cut into three or four boards or leaves, they will cost about 3s. 6d. And if the boards are bought planed, this will add only a few pence more to the price—bringing it up to 3s. 10d. or 4s. So whenever the amateur has to buy boards or leaves, it is better to buy them ready planed, whenever he can do so. Machine planing is however always somewhat rough; and if fine work is to be done the boards will commonly require to be touched up with the smoothing plane.

As to machine sawing, it may be as well to mention that tho price is 1s. 2d. for every 100 feet long of 9 inches wide; and 1s. for every 100 feet of 7 inches wide.

For the price of wood cut up into small slits or laths, see Chapter viii. (Paling).

Choose your own timber, and examine each separate piece to see that it be as straight-grained and as free from knots as possible. And in all cases buy timber as well seasoned as can be got.

CHAPTER II.

TOOLS.

General Directions.—In this chapter all the ordinary tools used by carpenters are described, and those that need it are figured. As the prices will vary according to size and quality, I have generally given several. Where some prices are printed in heavy figures, it indicates that the tools of corresponding sizes or qualities are preferred. Many tools not noticed in this chapter will be described as we go along, in connexion with the several kinds of work in which they are used.

Amateurs sometimes buy small bright ornamental tools, and not seldom pay high prices for them. But these are toy tools rather than real ones: they are pretty-looking, but turn out worthless after a little use. Workmen, who are the best judges, always buy plain tools: and plain tools are best.

It is better to buy tools singly, according as they are wanted: in this way the amateur can please himself in each individual tool, as to size, shape, and quality. It is not recommended to buy a tool-chest furnished, which is sure to contain tools that may never be wanted: besides, the quality of chest tools is not always to be depended on.

In some books the amateur is advised not to buy tools second-hand: I should be inclined to advise the very contrary. Second-hand tools can often be bought for less than half the price of new ones: and if they be not too much worn, it is well to buy them. These tools have been proved, and you usually know what you are getting; and they are

generally, to all intents and purposes, as good as new ones—indeed better than some new ones.

When buying second-hand tools, see that the chisel or hatchet is not too much worn away. See that the saw is not "buckled" or twisted, which you do by looking along both sides, lengthwise and across: if there is any twist from the level it will be detected. See that the sole of the plane is perfectly level—not worn away, so as to be either convex or concave. Look at the irons, that they are not too much worn. See that the face of the hammer is quite flat; if it is rounded avoid it.

An amateur cannot be expected to have tools of all the various sizes required by regular tradesmen; and it may be stated once for all, that he will find those of medium size most generally useful.

In general the best tools should be got, though they cost more than inferior ones; cheap tools are often a waste of money, for they commonly turn out useless, and give a great deal of worry.

Hammer.—A hammer neither too heavy nor too light is best, and will serve for most work an amateur is engaged in. But if much heavy work is to be done, an additional hammer, large and heavy, will be required. For occasional use, however, a hatchet answers very well in place of a heavy hammer, the back being used in striking. Some hammers have a claw for drawing nails. If there is a good pincers it is as well to avoid the claw hammer, as the handle is pretty sure to get broken by the constant straining; and there is great trouble in putting a new handle in.

A light sprig or tack hammer is very useful, and in some kinds of work, such as glazing, driving small nails into light work, &c., quite necessary.

Prices: Ordinary hammer, 9d., 1s., 1s., 4d., 1s. 8d., 2s.; sprig hammer, 9d.

Mallet—The wooden handle of a chisel, turnscrew, &c., should not be struck with a hammer,

which will disfigure or split the handle. For this purpose a mallet is used, which does not injure what it strikes. If not convenient to buy a mallet, it is very easy to make one, beech or some other hard wood being used for the head. A good medium size for the head is five inches long, with face four by three inches. *Prices :* 1s. 4d., 1s. 6d., 1s. 9d.

Bradawl.—The bradawl is bevelled at both sides at the point, so as to form a sharp, straight edge across. It is quite necessary to have a supply of bradawls of all sizes. They may be bought either with or without handles. Bradawls are used for soft wood; for hard wood a gimlet or a brace-and-bit is used.

Prices : Handled bradawls are sold in six sizes: price all round twopence each. Blades without handles: common sizes a halfpenny each; large size blades, up to three halfpence each.

Patent Tool Handle, or Pad.—This is a hollow handle containing from half a dozen to fifteen or more small tools, including bradawls and gimlets of various sizes, a reamer or scriber, a countersink, a turnscrew, a gouge, a file, a little saw, &c. The end of the handle screws off, and any tool that is wanting can be taken out.

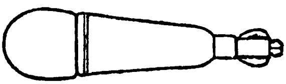


FIG. 1.

The tang or shank of the tool is inserted at the smaller end, where it is held immovably by a screw or spring catch; so that there is no danger of the blade remaining in the wood, as sometimes happens with a bradawl. These tool-handles, though seldom used by tradesmen, who regard them as toys, are extremely convenient and useful to an amateur. Take care not to screw home the end of the handle too tightly, or you may never be able to get it off—which happened to me once.

Prices : According to size and number of pieces,

from the smallest, with six bits, 1s., up to the largest, with fifteen bits, 3s. 6d. (Fig. 1).

Gimlet.—It will be well to have three or four gimlets of different sizes. Two kinds of gimlets are in common use, the plain and the twisted. In both there is a small pointed screw at the end, which penetrates the wood, rendering pressure unnecessary. In both there is a groove from the screw-point up half way towards the handle, through which the cut wood is forced upwards; but in the plain gimlet the groove runs straight, while in the twisted it runs spirally round the blade.

In all respects the twisted gimlet is better than the plain: it bores a smoother hole, is less liable to split the wood, bores more easily, and is less liable to break.

Prices: Shell, from 2d. to 4d.; twisted, from 4d. to 6d., according to size.

Brace-and-Bit or Bit-Brace.—A brace is an instrument of wood or metal, shaped something like a crank, and made to carry at one end a steel bit. The bits are of various shapes and sizes for boring wood, metal, &c.; and there may be any number of them up to forty-eight, which is commonly counted the full set. The bits may be bought singly. They are fastened firmly in the socket at the end of the brace by a thumbscrew, or by a catch in the brace which springs into a notch in the bit when the latter is pressed into the socket. By this contrivance one bit can be taken out and another put in its place in a moment.

The brace is used by holding the knob or stock B against the chest, and the point of the bit on the substance to be bored: the right hand turns the crank round and round from left to right, the chest and left hand supplying the necessary pressure.

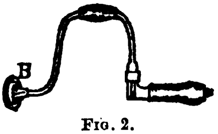


FIG. 2.

The American iron brace, shown in Fig. 2, will be found on the whole the best and most convenient. The bit is grasped by a chuck, which will hold almost any kind of bit as well as those made for it.

There is a great variety of bits: some are for boring simply, and are of all sizes, from $\frac{1}{4}$ inch up to 2 inches: these are commonly called centre-bits, from the pointed projection in the centre. Some are for countersinking (see p. 11); some for enlarging holes already made; some for screw-driving, &c. The screw-bit, which has a spirally twisted blade, is a most useful bit for boring hard or soft wood, and answers instead of an auger.

Prices: American iron brace, 3s. 6d.; common iron brace, 1s. to 2s. 6d.; centre-bits, quarter-inch, $3\frac{1}{4}$d., and up to 1s. 2d., according to size. Screw-bits from 1s. up to 2s. 7d., according to size.

Drill.—For boring small holes in metals there is a drill—often called the bevel-wheel drill—which by means of two cogged wheels, produces very rapid revolution in the bit. The bits are of different sizes, and can be taken out and replaced, like those of the bit-brace. Though this drill is intended for metals, it is often used for boring small holes in hard wood, bone, &c. *Price,* with six bits, 2s. 6d.

Archimedean Drill.—In the preceding drill, the bit always revolves from left to right. The Archimedean drill causes revolution in both directions alternately. It consists of a rod of iron cut for its whole length with a spiral groove, on which a knob moves freely up and down, having a spiral band fitting into the groove. While the stock is held to the breast and the bit against the object to be bored, the knob is moved backwards and forwards with the right hand, causing the rod and bit to revolve rapidly in alternate directions. *Prices,* 1s., 1s. 6d., &c., up to 7s.

Auger.—Augers are for boring large holes in wood, and are of various sizes, according to the size of the hole to be bored. The auger is an enlarged

gimlet, so made as to be used by both hands; and as in case of the gimlet, there are two kinds, plain or shell, and screw or twisted. The shell auger is used for rough work; the screw for fine. The American twisted auger is the best of all, and cuts a hole very rapidly and cleanly. There is at the end of most augers a small sharp-pointed nose-screw for entering the wood, which should not be subjected to rough usage, or it may be broken. Where there is a brace and-bit it often does the work of an auger. *Prices:* $\frac{3}{8}$ or $\frac{1}{2}$-inch shell, 8d.; $\frac{1}{2}$-inch screw, 1s., and up to 3s. or more according to size. American twisted or screw-auger, from 1s. up to 2s. 6d.

Reamer or Scriber.—A long four-sided piece of steel, tapering gradually to a sharp point, and set in a handle like a bradawl. It is very useful for enlarging holes in metal—as for instance, a hinge-hole, not large enough for the screw. The sharp point is used for marking lines on boards, &c. *Price*, 5d.

Countersink or Rosebit.—It is often necessary to enlarge a hole in wood or metal, just at the opening; for example, in screw-driving, where you have to sink the head flush (i.e. level) with the surface, in riveting, &c. This is what is called countersinking; and it is done by a countersink. But an amateur can well do without this tool: for he can easily countersink wood with a gouge, chisel, or penknife; and the point of a bradawl can be shaped with an old file into a countersink for rivet holes. *Prices:* $\frac{1}{2}$-inch, 5d.; $\frac{5}{8}$-inch, 7d.

Hatchet or Axe.—The edge of the hatchet is bevelled on both sides. There are many varieties of hatchets, for squaring, trimming, splitting, felling, &c. Some are so heavy that they require the two hands, some light enough for one hand. It is better to choose a hatchet of medium weight, which can be used with one hand, or both. A hatchet for general purposes may be of any shape to please the purchaser's eye.

To be of any use, a hatchet must be kept well ground and sharpened, and free from gaps. The back of a hatchet may be used as a hammer in heavy work: but this is dangerous and requires care. It is also used in clinching, the back being placed against the head of the nail, while the point is clinched with the hammer.

Prices: 1s. 6d., 1s. 9d., 2s., 2s. 6d., &c.

Chisel.—The chisel has its edge bevelled on one side and flat on the other. Chisels are of various sizes, from $\frac{1}{8}$-inch wide (at the edge) to 2 inches: as they are easily procured, they can be got according as they are wanted. They may be bought either with or without handles.

The ordinary chisel used in common carpentry work is what is called a *firmer* chisel. There is also a mortise chisel, which is made very strong in the direction of its thickness, as it is subject to much strain, and has to bear heavy mallet blows. For the same reason it grows thicker towards the handle, while the firmer chisel contracts. The paring chisel has a very long blade, but it differs in no other respect from the ordinary chisel.

The prices of the sizes most useful to an amateur are: with handles: $\frac{1}{4}$-inch, 6d.; $\frac{1}{2}$-inch, 7d.; $\frac{3}{4}$-inch, 8d.; $1\frac{1}{4}$-inch, 1s.: without handles: $\frac{1}{4}$-inch, $3\frac{1}{2}$d.; $\frac{1}{2}$-inch, $4\frac{1}{2}$d.; $\frac{3}{4}$-inch, $5\frac{1}{2}$d.; $1\frac{1}{4}$-inch, 9d. Mortise socket chisels, without handles (which are easily supplied): $\frac{1}{4}$, $\frac{3}{8}$, and $\frac{1}{2}$-inch, $10\frac{1}{2}$d. each.

Cold Chisel.—What is called a cold chisel is a strong piece of steel 8 or 10 inches long, brought to a blunt wedge-shaped edge at one end: it is useful for knocking off mortar, displacing stones, picking holes in walls, &c. *Price* from 1s. upwards.

Gouge.—The gouge is a sort of curved chisel; the bevel edge being on the outer or convex side. Gouges are of various sizes; but for an amateur—if he finds it necessary to have one at all—two will probably be enough—one $\frac{3}{8}$-inch, the other $\frac{3}{4}$-inch. *Prices:*

with handles, $\frac{3}{8}$-inch, $7\frac{1}{2}$d.; $\frac{3}{4}$ inch, 9d.: same two without handles, 5d. and 7d.

Plane.—A plane consists of a *cutting iron*, bevelled and sharpened like a chisel, and set at an angle in a piece of hard wood called the *stock*. The bottom or flat of the stock is the *sole*. The large hole through the stock in which the iron is fixed is the *throat;* the opening of the throat at the sole is the *mouth*.

For ordinary work two planes are commonly used, the jack-plane and the smoothing-plane. The jack-plane (Fig. 3), is the one first used for clearing the surface of the wood after the saw: its stock is 16 or 18 inches long; and, like several other planes, it has on the top a handle or *toat* intended for the right hand.

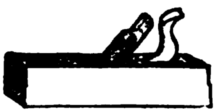


FIG. 3.

The smoothing-plane (Fig. 4), is much smaller—stock about 8 inches, curved sides, no toat; and it is used after the jack-plane to smooth the surface thoroughly.

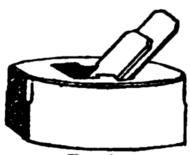


FIG. 4.

A trying-plane is longer than a jack-plane, and is used for fine work, where great precision is required.

But it must be observed that an amateur often has only one plane; and unless he does a good deal of fine work, one plane will answer all purposes. In this case it is best to have a jack-plane.

Plane-irons are usually distinguished, as to size, according to the width along the cutting edge: the two mentioned above may be $2\frac{1}{8}$ or $2\frac{1}{4}$ inches. Plane-irons of any given width may be bought in any good tool shop.

The iron of a plane usually consists of two parts, held together by a strong screw and nut, viz., the blade or cutting-iron, and the counter-iron, or top-iron, or break-iron. If the irons of a plane in ordinary

use be examined, it will be seen that the counter-iron is screwed on with its edge a little behind the edge of the blade or cutting-iron. The use of the counter-iron is to break and bend up the shaving towards the mouth of the plane the moment it is cut by the blade from the wood.

Plane-irons are set in the stock at various angles: the angle is called the *pitch*. The iron of the jack and smoothing planes is at an angle of 45°, which is called the common pitch, and is suited for general use in planing deal and other soft woods. For hard or knotty timber the iron is set more upright.

In the preceding planes the stocks are of wood. But planes have been introduced of late from America, made altogether of iron—except of course the cutting and counter irons, which are always steel. In these the plane-irons are easily adjustable by screws and levers, both as to the pitch, and as to the projection of the edge beyond the sole (*i.e.* so as to give *more or less iron*). These planes are more expensive than the common ones; but they are worth the difference for those who can buy them.

There are various forms of planes for moulding, rabbeting, ploughing, &c., but the amateur will probably have need for only two: a side-bead plane for simple bead moulding, A (Fig. 5), along the edge of a board, and a rabbet plane, for cutting a rabbet or rebate, B. The use of both is easily learned. Both are of different sizes, from $\frac{1}{8}$ inch upwards. A $\frac{3}{8}$-inch moulding plane, and a $1\frac{1}{4}$-inch rabbet plane will answer most ordinary purposes. With a $1\frac{1}{4}$-inch rabbet plane, one may make a rabbet of any width from the full width of the iron ($1\frac{1}{4}$-inch) down. A rabbet plane with a *skew* iron—that is, having the iron running obliquely across—is best; because it cuts more easily over knots and cross-

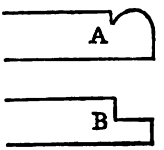


FIG. 5.

grains, and because it tends to keep the plane from slipping away from the rabbet.

Prices: $2\frac{1}{8}$-inch jack plane, 4s. 3d.; $2\frac{1}{8}$-inch smoothing plane, 3s. 10d.; $2\frac{1}{2}$-inch trying plane, 6s. 3d.; $\frac{3}{8}$-inch side-bead plane, 2s. 3d.; $1\frac{1}{4}$-inch rabbet plane, 2s. 4d.: plane-irons, single, *i.e.* without the counter-iron, $2\frac{1}{8}$-inch, 9d.; $2\frac{1}{4}$-inch, 10d.: double, *i.e.* with counter-iron; $2\frac{1}{8}$-inch, 1s. 4d.; $2\frac{1}{4}$-inch, 1s. $5\frac{1}{2}$d.

Spokeshave.—A spokeshave is a kind of rude plane set in a handle, which is held by the hands at both ends. It is very useful for cutting down and smoothing curved surfaces, where the plane cannot be used. The bevel of the cutting-iron is next the wood of the handle (the reverse of the plane). The iron is held to the handle by two tangs turned at right angles to the blade, which fit tightly into two holes in the wood, going through and through till they project at the other side. By a few light taps of a hammer on the tangs at one side or the other, the cutting edge can be brought nearer to or farther from the wood, thus giving more or less iron as in the plane.

In some spokeshaves the distance of the iron is regulated by thumbscrews; but these are expensive, and are little better than the common ones. There are American spokeshaves altogether made of iron—except of course the blade, which must always be good steel. The spokeshave is so called from its use in shaping and smoothing wheel-spokes—a good index of the uses to which it may be applied.—*Price:* With 3-inch blade, 10d.

Draw-knife.—The draw-knife or drawing-knife is somewhat like a spokeshave; it is a long knife held at the ends by two handles at right angles to the blade. The edge is bevelled like a plane-iron and is turned in the same direction as the handles. It is very useful for cutting down rough pieces of wood, as in shaping rungs for ladders, handles for

brushes, spades, shovels, &c. *Price*, with 8-inch blade 2s. 1d.

Penknife.—Carpenters will not use a penknife; but it is a most useful tool for an amateur. With a good penknife, pretty well worn, and kept sharp, a great many small jobs can be done, such as countersinking, making keyholes, making small cog-wheels, fitting the top of a stick for a ferrule, &c.

Saw.—There are many kinds of saws; but for an amateur three will answer all ordinary purposes—a handsaw, a tenon saw, and a lock or fretsaw.

The size of the teeth determines the coarseness or fineness of a saw. A hand-saw, having five of the spaces between the teeth equal to one inch, is a good medium for general purposes (the space being measured from point to point). A handsaw with teeth larger than this is scarcely suitable for amateurs.

The teeth are turned outwards right and left alternately, to make the cut or *kerf* wide enough for the blade to run freely: this is what is called the *set* of the saw. The size of a saw is usually reckoned by the length of the teeth-edge: a good medium length for a handsaw is 20 or 22 inches.

For cutting timber lengthwise, *i.e.*, with the grain, a handsaw with larger teeth is used—about $2\frac{1}{2}$ spaces to the inch. This is what is called a *rip-saw*. But a rip-saw is scarcely needed except by tradesmen; for the handsaw described above will cut with the grain very well, though not so quickly as the rip-saw.

A *tenon saw* (Fig. 6), is small and thin-bladed; and the blade has a brass guard on the back to keep it from bending. This saw is used for fine work, such as tenon-and-mortising, cutting mouldings, cutting small pieces across, &c. The teeth are much finer than those of the crosscut saw, so that the divided surfaces are

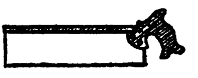


FIG. 6.

left pretty smooth. The teeth are a good size when there are eleven or twelve spaces to an inch. There is a very small tenon saw with still finer teeth, which is very useful for dovetailing, mitre cutting, &c.

A *Locksaw* is a long slender saw used for cutting in curves: a good medium length is twelve inches. A fret or keyhole saw, sometimes called a pad-saw, is much the same as a locksaw, except that here the blade, instead of being riveted permanently to the handle, is fixed to it by screws. The handle or *pad* has a slit through it from end to end for the blade to pass through, and the blade can be fixed in any position by two screws, so as to be long or short as you want it: or it can be detached altogether.

The fret-saw has this advantage, that if a blade gets broken it can be taken out and a new one put in, as the handle holds good; but if you break the blade of a locksaw the handle is useless, and you have to buy a new one altogether. The locksaw is, however, stronger and better suited to rough work than the pad-saw.

When the fret-saw is in use, the fastening screws should be made tight, or the blade may be forced backward and wound the hand. When not in use, the blade is kept in the slit of the handle, which covers it like a case.

Both lock and fret-saw are slender and very flexible, so that they easily cut in curves of any shape: hence, they are sometimes called *sweep-saws.*

There is also a small saw set in a frame—commonly called a *bow and frame saw:* this is much used for curve cutting, especially in fretwork.

Prices: Handsaw, 20 inches, 3s.; tenon-saw, 10 inches (for dovetailing, mitre cutting, &c.) 4s.; 14 inches, 5s. 6d.; locksaw, 12 inches, 1s. 2d.; pad-saw, small, 1s.; large, 1s. 4d.; blade alone, of any size, 4d.; bow and frame saw, 12 inches, 3s. 6d.; blade alone, 4d.

File.—There are files of all shapes and sizes for all kinds of metal work. The common three-corner file is used for sharpening saws; the rat-tail, or mouse-tail file, is long, round, and slender. Some files are flat on one side and rounded on the other, with two sharp edges: some are flat on both sides, with flat edges; and of these some have the two flat sides smooth, with the edges cut into teeth, while some have one edge smooth, and the other edge and the two sides cut with teeth. Each amateur will choose the shape he wants for his special work: and there is scarcely a shape, size, or degree of fineness that he will not find in good tool-shops.

A **rasp**, which is a coarser sort of file, is often found very useful for smoothing the curved surfaces of hard wood. Rasps are of various degrees of fineness; but a moderately fine one will be found most generally useful.

Prices: Three-corner file for saw, best, $4\frac{1}{2}$ inches, $4\frac{1}{2}$d.; second best, $3\frac{1}{2}$d. Rasps, from 4d. to 1s. 6d., according to size.

Turnscrew, or Screw-driver.—These are of various sizes, from 3 to 12 inches: eight inches is a good medium size. A large bradawl answers extremely well for small screws: but it should not be used for large screws, or where there is much strain. *Price:* an 8-inch turnscrew, 1s. 6d.

A Spanner, or Wrench, is used for wrenching or turning the nuts of screws; and where this has to be done often, as in case of bicyclists or tricyclists, this tool is quite necessary. There are several kinds of spanners which are adjustable: i.e., they can be made by a few turns of a screw to fit the head of any nut from an inch or so downwards. Fig. 7 represents one kind of spanner—a small one—which cost 2s.; the prices vary according to size, from that up to seven or eight shillings.

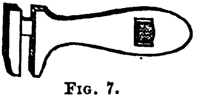


FIG. 7.

Pincers, Pliers.—A 6-inch pincers will be large enough. There should be a claw at the end of one handle for drawing small nails.

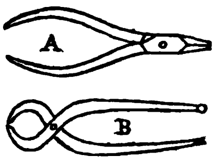


FIG. 8.

A pliers fitted to cut wire (often called a nippers or bell-pliers) will be found very useful: in all work where wire is used it is indispensable.

In Fig. 8, A is the pliers, and B the pincers.

Prices: A 6-inch pincers, 10d.; pliers vary in price according to size and quality, from 6d. to 3s. 6d.; a fairly good pliers will cost 1s.

Vice.—No one who works much in metals can do without a vice of some kind: and it is often very useful in carpentry work. A hand-vice is small, and is intended to be held in the hand. A bench vice is something larger, and may be clamped to a bench or table: but it may also be held in the hand. Some kinds of vice have parallel movement in opening or closing: others turn round a pivot: those that move parallel are the best. A small hand-vice can be got for 1s., a small bench vice for 2s., and a very good one for 4s. or 5s.

Rule: Tape.—A common 2 foot rule that folds up in four hinged segments will answer for all ordinary purposes. Some rules are graduated differently on two sides: one side eighths and sixteenths, the other side tenths and twentieths.

A small tape measure will be found extremely useful, and is indeed necessary when lines have to be measured along curved surfaces.

Price: 2-feet, fourfold rule, common kind, 6d. A small tape may be bought for a few pence, and a tailor's tape—5 feet long— costs only 1d., and will answer most purposes.

Square.—A square consists of a tongue or blade of steel with straight and parallel edges, fixed at right angles at the end of a piece of hard wood called a

stock. It is used for drawing lines at right angles to a straight edge, and for testing whether angles are right or not. A square having a 9-inch blade is of medium size. For making a square, see Chap. ix.

Prices: With 6-inch blade, 1s. 6d.; with 9inch, 2s

Bevel.—In this, the blade instead of being fixed as in the square, is movable round a centre, so as to form angles of any number of degrees with the stock (Fig. 9). The bevel enables us to draw lines forming any required angles with a straight edge. *Price*: medium size, 2s. 6d.

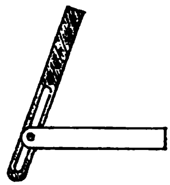


FIG. 9.

Gauge.—(Fig. 10). The gauge or marking gauge is used for marking a line along a surface parallel to and at any given distance from one edge. It consists of a straight bar of wood, or *strig*, furnished with a movable head or block, which slides on the bar, and can be fixed in any position either by a thumbscrew or by wedges. There is a short steel point projecting from one side of the bar. When the head is adjusted to the proper distance from this point, the gauge is drawn along the board with the head pressed against the edge to serve as guide, and the point pressed on the surface: this leaves a mark parallel to the edge, and at the required distance.

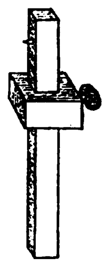


FIG. 10.

A gauge is used—among other things—in marking tenons and mortises. But there is a special mortise gauge, having two points, one of which is movable, and can be fixed at any required distance from the other; the head being also movable. This will mark the two sides of a mortise at once: but for an amateur a simple gauge will be quite sufficient.

Prices: Simple gauge, plain, 4d.; a mortise gauge, 1s. 9d. and upwards.

Compasses or Compass.—Any ordinary compass

will answer; but where there is much marking, and where precision is necessary, it is best to have a wing compass, which can be fixed immovably in any required position by means of a wing and a thumb-screw.

Prices: Plain, with 7-inch legs, 10d.; same size, with wing and screw, 1s. 4d.

Level.—For ascertaining whether surfaces or lines are horizontal, a level is used. Of the several kinds, a spirit level is best. It consists of a long straight piece of hard wood, with a glass tube lying along a groove in its upper surface. This tube is filled with spirits of wine, containing a bubble of air. When the instrument is lying exactly level, the bubble is in the middle of the tube; but if one end be in the slightest degree higher than the other, the bubble moves towards that end. *Price:* Small size, 1s.

A Plumb-level.—(Fig. 11), is used to test whether the face of a wall, the jamb of a door, &c., is truly vertical. It will cost from 6d. upwards: but it is very easily made. Get a piece of inch board, say 30 inches long and 5 inches wide: sides perfectly straight and parallel. Draw a pretty deep mark along the middle of one side, from one end to the other. Near one end cut a hole 2 inches in diameter; and at the other end cut with a saw three little nicks half an inch deep, the middle one in the very centre. Fasten a leaden plummet at the end of a string, and tie the string in the nicks so that it will stretch along the centre mark with the plummet reaching just as far as the hole. When you place the side of the board against a wall, the string will fall exactly along the mark if the wall be vertical: otherwise not.

FIG. 11.

Nail Punch.—The punch—which is of steel—is necessary for driving nails home, so as to bury the heads deep in the wood: if they are driven by the

hammer, the wood will be battered where struck. *Price*, 2d.

Grindstone.—Grindstones are made of all sizes, from 6 or 8 inches in diameter upwards: a good size for general use is 12 or 15 inches. A grindstone should be furnished with a crank and treadle at the right hand side, so that the operator may himself turn it with his foot while grinding. But there is always an ordinary crank-handle at the left hand side, so that a second person may be got to turn if necessary. There is usually a trough for water underneath into which the stone dips as it turns round, so that it keeps wet. In this case the trough should be emptied after each grinding; for it injures the stone to be constantly steeped in water. This can be done by a common spigot. Instead of the trough, some grindstones are furnished with a funnel-shaped tin vessel, suspended over the stone by means of a wire, point downward, from which water drips on the stone: this is regarded a cleaner and better plan than the trough.

The stone must be accurately centred, so that it will move freely without wobbling. A small bench grindstone, 9 or 10 inches in diameter, which is made to stand on a bench or table will answer very well for an amateur.

Prices: Very small bench grindstones can be bought for 4s. or 5s.: a good bench grindstone for 10s. But a large grindstone, fully furnished with trough, crank, &c., will cost from £1 to £2 5s., or even more.

Whetstone.—In the absence of a grindstone, which is expensive, edged tools—when they are not very much worn—can be ground very well, though slowly, on a common whetstone. When tools are blunt, though not much in want of grinding, they can be sharpened roughly at first on the whetstone, and finished off on the oilstone.

Oilstone.—There are several kinds of oilstones—

Turkey, Washita, Arkansas, Grecian, &c., any one of which will answer all ordinary purposes: but Turkey and Washita are considered the best. *Prices:* Grecian hone, middle size, 1s.; Turkey and Washita are sold by weight: price, 2s. per lb.

Gouge-slip.—For sharpening a gouge a thin flat stone called a gouge-slip is used, having its two parallel edges rounded for rubbing up and down on the concave or inner side of the gouge. *Prices:* Grecian, 8d.; Turkey, 10d.; Washita, 1s.

Glue-pot.—A glue-pot consists of two little iron pots, one within the other, the inside one to hold the glue, the space between, water. The whole vessel is put on the fire till the water boils, which dissolves the glue. *Price,* 1s. In the absence of a regular glue-pot, glue may be melted in any small pot.

Oil-can.—The common oil-can is funnel or cone-shaped, having the nozzle projecting from the apex: the nozzle comes off by a screw, to allow the can to be filled. The oil is forced through the nozzle by pressure on the bottom, which yields with a sharp click; and returns in like manner when the pressure is removed. Other oil-cans are shaped like a watch, and the sides are pressed to force out the oil. *Price:* 4d. or 6d.

Bench.—If much carpentry is done, one needs a bench, which is a sort of table with thick legs and a strong heavy top. A good size is 6 feet long, 2 feet wide, and 2¾ feet high. On the left hand side there is a screw—which is sometimes of iron and sometimes wood—with a jaw or vice to hold boards edgewise for planing. On the upper surface there is a movable stop for the end of a board when lying flat to be planed. And on benches of the more elaborate make, there are various other adjustments.

A bench is an expensive article: the plainest one, with a wooden screw, will cost £1: and the prices run up even to £10. But an amateur, to whom money is an object, may make a bench for himself

with small difficulty, and at a very moderate expense. The way to do this will be found fully described in Chapter ix.

For occasional jobs, a common kitchen table will answer very well for a bench, if the workman puts the end against the wall and adopts those simple plans for holding boards for planing, &c., described in the fourth chapter.

CHAPTER III.

SHARPENING TOOLS AND KEEPING THEM IN ORDER.

Tools to be kept free from rust.—Tools should be kept in good order; the metallic surfaces bright and free from rust; the handles smooth and free from fractures. They should be kept in a dry place; or if in a place where there is the least appearance of damp, the metal surfaces should be kept greased, which will preserve them from rust. Paraffin oil is good for cleaning off rust; but it will not preserve the surface long, as it soon dries off. An excellent preservative is common lard, melted up with a bit of camphor—say a $\frac{1}{4}$-ounce of camphor to $\frac{1}{2}$ lb. of lard. Grind the camphor and mix it with the lard; then melt. With a bit of flannel rag rub a thin coating of this on saws, chisels, hatchets, &c., and they will keep bright anywhere for almost any length of time. (Camphor may be bought for 2d. an ounce.)

Necessity for sharpening.—Edged tools must be kept well sharpened. You will see a skilled workman stop up very frequently in the middle of his work to use the oilstone: and the total amount of time spent at this, will rather surprise an inexperienced person. But this is quite necessary; for with blunt tools the work will be slow, laborious,

and vexatious, and the workmanship will be rough and unfinished. The oilstone should be kept always at hand ready oiled, so that the chisel may get a rub or two at any moment without loss of time.

The amateur must therefore learn in the first instance how to sharpen his tools. The instructions that follow will be found, I hope, plain enough: but it will make the thing much easier for the learner if he can manage to look at a good workman sharpening, or get some practical instructions from him.

Oilstone.—In sharpening, we use sweet or olive oil, which gives a much finer edge than water. In the absence of sweet oil, paraffin oil may be used; and failing both, water.

The surface of the oilstone must not be let grow concave by use: unless it is level you cannot sharpen accurately on it. Should the stone be worn unevenly, so that it becomes concave, either lengthwise or across, it should be ground flat by being rubbed face down on a rough flat-surfaced stone.

Sharpening bevelled tools.—All tools with the edge bevelled on one side and flat on the other —chisels, plane-irons, scissors, shears, &c.—are sharpened much in the same manner. The following is the way to sharpen a plane-iron or a chisel.

The angle of the edge of a new chisel or plane-iron is a little smaller than the angle intended for use, so as to leave room for sharpening easily. The angle when new is about 25°; but it is sharpened at an angle of about 35°; and it must therefore be held at an angle of 35° on the oilstone, as shown in Fig. 12. The surface formed by sharpening (i.e. the surface A B) must be quite flat: in order that this may be the case, the sharpener must take care to

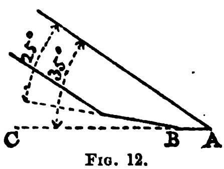


FIG. 12.

keep the chisel always at the same angle; otherwise the surface near the edge will get rounded. The number of degrees is given for information sake. The sharpener of course cannot measure degrees while sharpening; but he will get a good idea of the way to hold the iron from the figure.

When the stone has been used enough, the edge will possibly be found to be slightly turned to the other side, showing a kind of thread along the edge, called a *burr* or *feather* or *wire-edge.* To remove this, reverse the iron and rub it *perfectly flat* on the stone. After this a few light rubs on both sides alternately will likely be necessary before the edge is perfect. The workman should however, as far as possible avoid sharpening so far as to produce a wire edge; for it wears down the tool very much. Fig. 13 shows how the iron is to be held while sharpening.

Remember that when the flat side is rubbed, the chisel must be held lying quite flat on the stone: if the hinder part be raised ever so little, the edge becomes slightly bevelled on this side also, which spoils the tool. Travelling knife-grinders, if not watched, often do this to chisels and plane irons in order to spare themselves trouble; so that an amateur should be very careful how far he entrusts his tools to them.

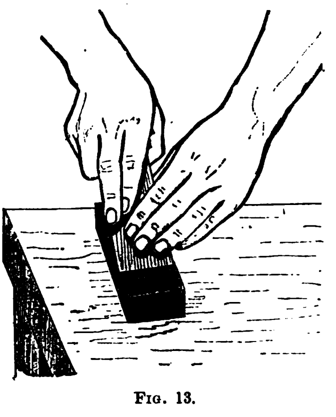


FIG. 13.

According as the oilstone is used, day after day, the surface formed by it next the edge of the iron (i.e. the surface A B Fig. 12), grows wider and

wider, till at last the iron takes a very long time to sharpen. When this happens, or whenever the chisel or plane-iron gets gapped, it should be put on the grindstone, or ground on a good whetstone, till the edge becomes the same as it was when new: after which the oilstone again comes into use.

In order to sharpen a plane-iron, it must be taken out of the stock, and the cutting-iron separated from the counter-iron. For the manner of doing this see Chapter iv. If it be a smoothing or a trying plane, great care must be taken that the edge be a straight line the whole way across, otherwise the board cannot be planed level. But the edge of a jack plane is usually a curve, with a very slight convexity. The extreme corners of all plane irons may be, however, very slightly rounded off. The edge must be kept exactly at right angles to (or square with) the length, which can, of course, be tested by the square.

In the case of scissors, it is quite necessary—more so even than in any other bevelled tool—that the inner sides of the edges be perfectly free from bevel, so that the edges may be in complete contact in the act of cutting. Yet scissors, of all tools, are oftenest spoiled by having the flat surfaces slightly bevelled. If a scissors be very blunt, it must be ground either on a grindstone or on a whetstone; after which use the oilstone. If the blades have got very loose the rivet should be tightened by hammering it with a light hammer down on the side of a hatchet, or on a common smoothing-iron.

To sharpen a Hatchet.—A hatchet is generally sharpened on the grindstone, or on a whetstone; but the oilstone is used to finish off if a fine edge be desirable.

To sharpen a Gouge.—The convex side of a gouge is worn down on the ordinary oilstone or whetstone. Take care (1) to keep it uniformly curved; (2) to

hold the tool on the oilstone as a chisel is held, bringing the several parts of the curve successively on the stone. The wire-edge, which in this case—if it appear at all—will appear on the concave side, is removed by rubbing the rounded edge of the gouge-slip up and down along the concave.

Turnscrew.—Keep the edge of the tunscrew to that degree of sharpness to match the notches of the screws. If it be too sharp, or the angle too small, the edge is apt to break or turn; if it be very blunt, or the angle too large, it will not catch the screw-notch. Keep the edge a straight line across, not a curve.

Use of the Grindstone.—In grinding plane irons or chisels on the grindstone, the tool must always be held at the same angle. In order to do this the hands must rest on some support: every good grindstone is furnished with a support of some kind for this purpose.

If a grindstone be furnished with a treadle and crank, the sharpener can turn the stone for himself while grinding.

The edge of the iron should be held pointing away from the operator, and the stone should revolve towards him. This is the best way to grind; but the workman is liable to get splashed. If the grindstone be caused to revolve the other way—*from* the operator—the splashing will be avoided; but the plan is not so good.

In grinding small irons such as a $\frac{1}{2}$-inch chisel, take care to vary the position so that the surface of the stone be worn uniformly, i.e., so that it will keep flat across. If small tools be held always in the middle, the surface of the stone will become concave across—a channel getting worn in the middle all round—so as to make the stone unfit to grind large tools, such as a hatchet, a broad chisel, &c.

If a grindstone gets worn unequally it must be made even by turning it round rapidly while a straight

edge of iron or steel is held stiffly against the surface, so as to wear down the projecting parts till the surface becomes even. A whetstone, if it become uneven, is levelled like an oilstone.

Sharpening and setting a Saw.—A saw should be kept well sharpened and well set. The teeth of a saw are turned alternately a little right and left, so that the cut or *kerf* may be wider than the thickness of the blade. After some use the sharp points that project right and left get worn or broken off: then the cut is not wide enough and the work becomes laborious and irritating. When this happens the saw needs setting, i.e., increasing the bend of the teeth right and left.

For this purpose a saw-set is usually employed. The saw is held in a vice, or what is just as good, between two boards screwed up, so that the teeth may just project; and the teeth are caught in one of the deep nicks of the saw-set, and turned to the right and left alternately.

In using the common saw-set the teeth are liable to break; and this will sometimes happen even with the most careful setter. There is a *gauge saw-set* that avoids this danger: it bends the tooth just as far as is needed, and no farther. The common saw-set is sold for about 10d.; the gauge saw-set for about 3s.

Sometimes the teeth are set by being struck with a small hammer while the saw is lying flat on some metallic flat surface: the alternate teeth are struck in one direction, and the others in the opposite direction, and occasionally this is done with a small steel punch. To set with a hammer requires great practice, and the amateur had better not attempt it; but anyone can learn to set a saw with a punch.

As to sharpening. It is not easy to teach a person to sharpen a saw by written instructions; but anyone with a little wit, by looking at the teeth, will see the way to sharpen them. It is done with a three-corner

file while the saw is held in a vice or between boards. A few rubs between each pair of teeth will be sufficient to give each tooth a sharp point. Keeping at one side of the saw, you file into the alternate angular spaces, the other spaces being filed from the opposite side. The best way to learn both to sharpen and set is to look at a good workman, and try to imitate him.

Carpenters and joiners are always able to set and sharpen their own saws, and an amateur can learn to do the same; but if a large tool-shop be near, it will be better to get it done there. The usual charge in these places for setting and sharpening a saw is 4d.

CHAPTER IV.

THE USE OF TOOLS.

General Instructions.—There is a right way and a wrong way of handling and using almost all tools. Some tools are so simple in use that most people with an ordinary share of wit can handle them properly. Others demand teaching, some degree of effort after the right way, and some practice and perseverance.

This is an important matter to those who work much, especially where the work is heavy. If a man handle his tools awkwardly, or place himself in a wrong position while working with them, a considerable part of his strength is wasted in doing useless work. Whereas if he handle and work them in the way that long experience teaches to be the best, the whole of the strength he puts forth goes direct to do the work intended. This explains why one man is fresh and another tired after their day's work, though both are about equally strong, and both have done the same amount of work.

An amateur has not the advantage of regular teaching like an apprentice under a good master, and he must pick up his technical knowledge and

learn the use of tools as best he can. It is hoped that the following instructions, supplemented as they are in many instances by diagrams, will greatly aid the learner in acquiring a right hold of his tools, and a right position in working with them.

The amateur should as often as possible see regular tradesmen at work; and if he observe them with common attention he will learn a great deal. If they have been well taught, their manner of holding, sharpening, and using their tools is the best: and he should endeavour to imitate them. This endeavour after the right way is all the more necessary, inasmuch as in learning to use some tools an uninstructed beginner, left to his own devices, is almost certain to fall into the wrong way.

Boring.—In boring with a bradawl, gimlet, or brace-and-bit, care must be taken that the hole be in the right direction. The usual direction is at right angles to the surface: and a beginner often finds it hard to keep it so.

In using a bradawl, the handle is grasped in such a way that the fore finger extends along towards the blade. *The edge of the awl must be placed across the grain*, otherwise it is likely to split the wood.

If the piece to be bored is very thin and liable to split, the bradawl must be pressed very gently, and the hole must be bored slowly and gradually. But sometimes the wood will not bear either bradawl or gimlet: in this case use a bit-brace with a spiral bit, or a centre-bit, neither of which is likely to split wood.

Sometimes, in boring with a bradawl, when you attempt to withdraw the blade, it sticks in the wood while the haft comes away—a most vexatious accident. In this case the steel must be withdrawn with a strong pincers or a small vice, and the tang or shank must be again driven home into the handle, after the hole has been plugged with a bit of soft wood. The steel is best driven home by using a small vice. Insert the blade point down between the jaws, which are closed so as to admit the blade as far as the shoulder, which stops further advance;

then strike the end of the handle till the blade is driven home. A common bit of beech—not too slender—makes as good a handle as those you buy, and has often a firmer hold of the tang.

The withdrawal of the haft is so annoying that many prefer to use the pad-handle, described at page 8.

Hammer.—Most people easily learn how to hold the hammer. The handle must be grasped, not quite at the end, but near it, so that an inch or so will project behind the hand (Fig. 14). The blows must be *square*, i.e., the hammer must come down perpendicularly, so that the face may strike flat on the surface.

FIG. 14.

The Plane. — *To withdraw the iron*: grasp the plane in the left hand, with the thumb down the throat, pressing on both iron and wedge (Fig. 15). Strike a few smart blows on the stock beyond the opening; each blow loosens the wedge a little, till at last both wedge and iron come out. The thumb keeps them from *falling* out. In a smoothing plane, which is very short, the blows may be struck on the near end of the stock.

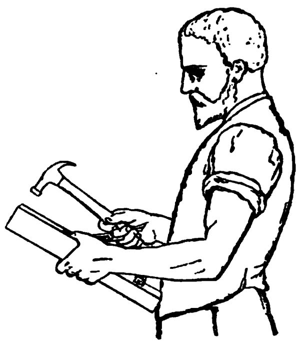


FIG. 15.

To separate the irons (see p. 13). With a screw-driver turn back

the binding screw till the irons are sufficiently loose for movement; then move back the counter-iron till the large round hole comes directly under the screw head: it will then come off. To screw the irons together, reverse the last process (but see p. 34 for the manner of doing this with the proper adjustment).

To replace the iron in the stock.—Hold it in its place with the left thumb, while the left hand firmly grasps the stock; then with the right hand put the wedge into its place, and drive it home gently with a few light taps till it is tight enough. Beware of wedging too tightly.

To adjust the iron.—In the process of planing, it will be found necessary that the cutting edge of the iron project sometimes more and sometimes less below the sole. This is what carpenters call giving more or less iron. You always judge whether you have iron enough by looking along the sole, when you can see the edge projecting (Fig. 16). A little experience will enable you to determine by the eye the proper projection.

FIG. 16.

To give more iron.—Drive the iron forward with a gentle tap of the hammer; if this is not enough give another; and so on. Look along the sole after each tap, and when at last the iron is right, give the wedge a slight tap; for any movement of the iron tends to loosen the wedge.

To give less iron.—Tap the stock with the hammer or mallet as if the iron were to be withdrawn; but let the taps be gentle. Every tap on the stock brings

back the iron a little. When at last the iron is right, give the wedge a final tap.

The iron must project evenly, i.e., not more at one side than at the other; a glance along the sole will tell if it does so or not. If it is not even, make it so by striking the top of the iron sideways at the same side as the over projection (Fig. 17).

FIG. 17.

The more the edge projects the thicker will be the shaving, and the coarser the work. More iron is required in the beginning, when the board is rough, than afterwards. Less iron is required for the edge of a board than for the broad flat surface.

To adjust the edges of the cutting-iron and the counter-iron.—The finer the planing is to be, the nearer the edge of the counter-iron must be to the edge of the cutting-iron. For the first rough planing the distance may be $\frac{1}{10}$ or $\frac{1}{12}$ of an inch. After this—when the finer work comes on—the irons should be taken out, unscrewed (p. 32), and the distance of the edges made smaller—as small as $\frac{1}{20}$ of an inch—and in a smoothing plane it may be still smaller. At the same time—as the irons are out—the cutting-iron should get a little of the oilstone before screwing together. Then the iron is replaced in the stock with the least possible projection, for finer shavings.

Planing.—The most difficult thing for the beginner is the adjustment of the irons to suit the various surfaces to be planed, as described in the preceding paragraphs: and this is the very first thing to be learned. Here, as in many other cases, a few practical

hints from a skilled workman will be of the greatest service.

See that the board about to be planed is free from grit or dirt, which would dull or gap the edge of the plane-iron.

Suppose an ordinary board, fresh from the saw, is to be planed perfectly smooth. The jack-plane is first used, to take off the roughness. The board must lie flat, either on a bench or on a firm table; and the far end must abut against a wall or against some other firm support. In a bench there is a stop for this purpose (see "Bench").

When a table is used as a bench, and when the board is short, its far end may be made to rest against the head of a wood-screw, driven into the table for the purpose—driven so far that the head will be lower than the upper surface of the board, so that the plane will work free of it. And other supports will suggest themselves to those who often use the plane.

Grasp the handle of the plane with the right hand, keeping the fore-finger extended so as to touch the iron. Place the left hand on the front or toe, with the thumb on the left side of the stock, and the four fingers on the right side; the back of the left hand will then be turned towards the operator's face. Fig. 18 shows how the plane is held; Fig. 19 shows the position of the body.

Begin to plane at the near end, and at the left hand side of the board. Keep equal pressure on front and back, so that the sole will run exactly parallel with the surface.

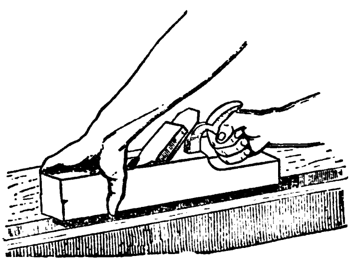


FIG. 18.

When drawing back the plane after each stroke, keep it slightly tilted over on one angle to prevent the iron rubbing on the board.

FIG. 19.

When planing the near end keep the toe pressed down sufficiently, else the shavings will be too thick at that end. When planing the far end, keep the heel sufficiently pressed down, else the shavings will be too thick at that end. Beginners often err in both, and the two ends get planed thinner than the middle. This tendency is still more observable in planing the edge of a board, so that a beginner is apt to take thicker shavings off the two ends than off the middle, making the edge a convex curve, instead of being straight. This is what is called *planing round.*

For the first few strokes of a jack-plane on a sawed board the iron seems not to bite, though it projects the proper distance. The amateur must not be discouraged at this; let him persevere with steady, firm strokes, and he will find the iron bite more and more, till at last it takes out the full size of shaving. Although the plane seems inoperative at first, it is really doing its work, by removing the higher prominences. The operator must not attempt to hurry on the work by driving the iron very far out, which will make the shavings coarse and the work rough.

If the surface of the board be damp, or if there be much resin in the timber, there may be considerable friction, and the plane will move with difficulty over

the surface, adding much to the labour. This will be remedied by rubbing the sole with grease or oil. A tallow candle is one of the best kinds of grease for this.

As the board grows smooth, the level is proved by placing one edge of the plane on it, and looking through at the light: do this in several places, both straight across and obliquely (see Fig. 20). Wherever the surface rises too much, apply the plane till it is brought down to level.

FIG. 20.

The Smoothing-Plane.—When the surface has been sufficiently levelled with the jack-plane, then comes the smoothing-plane. As already mentioned, the edges of the two plane-irons must be very near—$\frac{1}{30}$-inch or less. There must be very little iron; for the object is, not to level, but simply to smooth: and the shavings will be extremely thin. The strokes must be short and quick, often obliquely as well as with the grain; and they must be repeated over every part till the whole surface is perfectly smooth.

To plane the edges of a board.—If the edges need to be only moderately straight and smooth—as, for instance, the edges of a shelf—and that accurate squaring is not wanted, the board can be held with the left hand, the far end resting on the floor, or on a table, while the right hand works the plane—which, in this case, may be either a jack or a smoothing-plane.

But if it is necessary that the edges should be straight and square, the jack or trying-plane should be used, and the board must be fixed firmly standing on edge. This can always be done where there is a

bench (p. 23). But if the work is to be done on a common table, there are several contrivances for fixing the board, two of which I shall describe.

Holdfasts.—Get a piece of board about 2 feet long, 9 inches wide, and 1 inch thick, and cut a notch in it, as shown in Fig. 21, about 5 inches deep and 3 inches wide. Wedge the board edgewise into this notch: it will then stand edgewise on a common table, and it can be planed on the upper edge if the far end abut against a wall or any other firm support.

FIG. 21.

The following holdfast is, however, the best of any, in the absence of a bench. Get two pieces about 8 inches long, $3\frac{1}{2}$ inches wide, and $1\frac{1}{2}$ inch thick, and bevel one edge of each, so that one face will remain $3\frac{1}{2}$ inches wide, while the opposite face will be reduced to 3 inches, the bevel to run across the whole

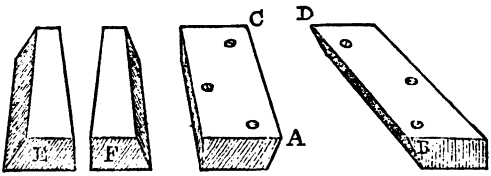


FIG. 22.

edge. Screw them down on the bench or work-table, as shown by AC and BD in Fig. 22, with the bevelled edges facing each other, so that the point A will be 5 inches from B, and the point C 3 inches from D. They must be very firmly screwed down, as they will be subject to considerable strain.

Get two blocks or wedges, E and F, each the same length and thickness as the two former pieces, and each $2\frac{1}{2}$ inches wide at one end and $1\frac{1}{2}$ at the other end. Square up the edges very accurately (see "Squaring up"); bevel them, as shown in the figure, to a depth of $\frac{1}{2}$ an inch along one angle, so as to correspond

with the bevels of the two fixed pieces A and B. It will be better if the whole four be of hard wood (p. 1): but good deal will answer very well.

By means of these four pieces any board from 2 inches thick down can be firmly fastened in its edge, either at one end or along any part of its length. Put the board standing on edge between the two fixed pieces AC and BD, and put in the two wedges, one on each side, so that their squared edges will be up against the board. Drive them home with a few *gentle taps*, and the board will then be firmly gripped. It can be instantly released by a tap in the opposite direction. These four pieces once made can be kept for future use.

To plane an edge across the grain.—To do this properly, the plane must be sharp, and have little iron. Plane from the near corner about three fourths of the whole edge: if the plane is run the whole way, the far corner will chip off. Then reverse the position and plane in like manner from the other corner. Better in this case to have a guide line on each side of the board, drawn of course with square and pencil. While planing, the board can be held with the left hand while it leans against the edge of a bench or table.

The grain.—Timber must be planed with the grain. If the grain runs all along parallel with the surface, there is no choice, and the plane may be run either way. But if the grain run obliquely, as in Fig. 23, the plane must run from A to B, not the reverse. If the grain be in different directions at the two ends, one end must be planed in one direction and the other in the contrary direction to suit the grain. If the grain be very irregular—which is often the case in bad timber—you must only take the surface as it comes; but the plane must be very sharp, with very little iron, and the strokes must be short and decisive.

FIG. 23.

A little practice will make the learner able to plane any surface, no matter how irregular.

The shavings generally come up of themselves through the throat; but if they accumulate, keep the throat clear with the left hand. Sometimes a doubled-up shaving sticks in the mouth, preventing the iron from biting: this must be at once removed with the left hand.

Rabbet and Moulding-Planes.—No instructions are necessary on the method of using the side bead-plane (p. 14). A $1\frac{1}{4}$-inch rabbet-plane is better than a narrower one, for with this a rabbet of any width from $1\frac{1}{4}$-inch down may be made. When carpenters use this plane to make a rabbet less than $1\frac{1}{4}$-inch wide, they guide the plane along with the fingers of the left hand placed underneath, till the rabbet is deep enough to guide the plane without help. But an amateur may not be able to do this, and had better adopt the following plan. Suppose a $\frac{3}{4}$-inch rabbet is required: nail temporarily a straight-edged slit along within $\frac{3}{4}$-inch of the edge, and this will guide the plane.

A rabbet-plane can be used to rabbet across the grain, a thing sometimes wanted: but for this use it must be very sharp, and there must be very little iron.

Although people generally use two planes at least, yet an amateur may often content himself with one —whether jack or smoothing-plane—with which a board may be smoothed quite well enough for many ordinary purposes. It would be quite unnecessary to carry out all the technical rules of planing for the laths of a paling, kitchen shelving, &c., for which one plane will answer perfectly well.

The Saw.—Suppose a board is to be cut across at a certain point, square with the sides. Mark a pencil line across with the square. *A saw-cut should never be run without a mark.* Place the board either on two trestles (like that in Fig. 24), or on two chairs,

or if it be short, on one chair. It is to be held down in the right position, with the right knee and left hand, or with the left hand only, according to convenience (see Fig. 24).


FIG. 24.

With the left hand grasp the edge of the board near where the cut is to be begun, so that the top of the thumb will be even with the guiding line, pressing the palm down to hold and steady the board.

Grasp the handle of the saw with the right hand, the forefinger stretched along towards the blade, and the three other fingers in the opening or loop of the handle. Place the middle of the edge of the saw at the beginning of the guiding line and slightly to the right of it, so that the kerf will just graze the line; the left thumb-nail will then just touch the blade.

To start the cut.—Draw the saw backwards two or three times without any pressure. In the notch thus made begin the cut very gently and without pressure for the first two or three strokes. After this, when sawing, move the saw forward and backward *its whole length.* It will require little or no pressure: the mere weight of the blade is almost enough: heavy pressure tends to make the saw depart from the line. The eyes should be kept over the saw, so that the workman can see on both sides of the blade.

Sawing.—The universal fault of beginners is to saw by short jerky strokes, using only about a third of the saw: on the contrary, each stroke should be long and deliberate, and the blade should be used its

whole length. In drawing back the saw take care not to pull it out altogether: if this happens the point may strike against the solid wood at the next forward stroke, and the saw may be bent and permanently injured.

The chief difficulty in sawing is to keep the saw in such a position that the cut will be square with the surface of the board, and will run evenly along the line. To do this, the right elbow must be kept pretty close to the side, and the saw must be held exactly perpendicular to (or square with) the surface.

The saw is kept in its proper position by the eye: but try now and then, with a small square (or anything with a square angle, such as a book or a slate) if the blade be square with the board.

A beginner commonly keeps the elbow too far out from the side, and thereby turns the handle too much to the right, thus turning the blade out of the square.

The cut must run along at the *right side* of the guiding line, just beside it, but not on it, so that the line remains untouched after the board has been cut through. If the saw departs from the line, it must be brought back by slightly twisting the blade in the other direction, while sawing.

The line should be followed as closely as possible: if the saw departs much from it there will be trouble afterwards in planing up. If the piece to be sawed is thick, it is a good plan to put a line on each side. Then, as you saw, examine the under side now and then. If the saw, while keeping to the upper line, has departed from the lower line, the piece may be reversed and sawed from the other side.

When the cut is nearly through, catch the piece with the left hand to prevent it falling off by its own weight, and breaking the edge: and after this finish off with short light strokes, so as to avoid fracture.

In sawing a board along the grain, or rip-sawing, as it is called, a very distinct line should be marked, either with a pencil and long straight-edge, or better with a chalk line (see "Chalk line"). If the cut closes in and binds the saw, insert some sort of wedge in front—a thick awl, a turnscrew, or a chisel will do (Fig. 25.)

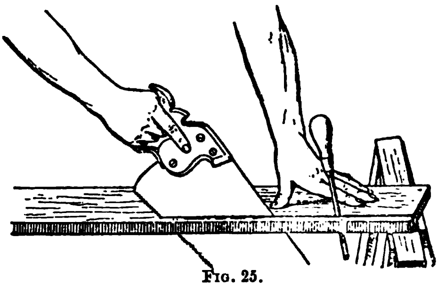


FIG. 25.

In sawing across the grain, if the saw moves through the kerf with difficulty, keep a little grease rubbed on the sides of the blade: the best grease for this is the end of a common tallow candle. But if this occurs often, and that the grease fails to free the blade sufficiently, the saw wants setting (p. 29).

CAUTIONS.—Never cut with a chisel or a knife towards your hand, or towards any part of your body. When paring with a chisel or knife, while holding the piece with the left hand, keep the left hand well behind.

When cutting with a hatchet, while holding the piece with the left hand, keep the left hand well away—as far away as possible.

When starting a saw-cut, take care that the saw does not jump from the board and tear your left hand.

CHAPTER V.

JOINERY.

Different kinds of joinery.—A considerable part of the operations of carpentry consists in joining pieces of wood together. It is of great importance, then, to learn to join in all the various ways; to join well is a proof of skill whether in a tradesman or in an amateur.

Pieces of wood are joined together in many ways. The principal are:—1. Dowelling; 2. Joining boards edgewise (so as to form one continuous board); 3. Mitring; 4. Halving; 5. Tenon and Mortising; 6. Dovetailing.

Before describing these, I shall speak of gluing, which is sometimes used by itself in joining, and sometimes in conjunction with the joints above-mentioned, to strengthen them.

1. *Gluing.*

Buy the best glue. The best glue is sold in clear, hard sheets; inferior glue is dark and soft; very bad glue is streaky and dirty with impurities, which can be seen by looking through. The best glue is 6d. per lb.

To make glue.—Put some glue, broken up into bits, in the inner glue-pot (p. 23), with a little water, and let it steep for a night. This night's steep is not necessary, but it will soften the glue, and make it easy to melt. Put the proper quantity of water in the outer pot, and having put the inner pot in its place (containing the steeped glue covered with water), set the whole on the fire till the water in the outer pot boils. This will melt the glue, which should be kept stirred to mix it well with the water.

To be fit for use the melted glue must be of the consistency of thin cream: if it be too thick it will not stick well. To find if it be of the right thickness, dip

in a splinter of wood, lift it out, and let the glue drop. It should drop pretty freely; if it falls tough and stringy, it is too thick; if it runs quite like water, it is too thin. If it be too thick, add a little boiling water while the glue is on the fire, stirring till the whole is uniform; if too thin, add a few bits of glue till melted. The proper consistency will be easily learned after a few trials.

When glue, after being used, is laid by, it is almost always too thick when next you want to use it; so that it will be necessary to add some water.

To apply glue.—Glue is applied with a brush. An old paint brush will do; but a small brush that will answer quite well may be bought for a couple of pence. Anyone can make a glue-brush in a few minutes by tying a short little bunch of hair from a cow's tail on the end of a bit of stick. Indeed glue can, in most small jobs, be applied with a broad, thin splinter of wood. After using the glue, the brush—if a brush is used—should not be left standing in the glue-pot, but should be washed well in water till free from glue, and put aside.

To glue surfaces together.—Any two surfaces that are to be glued together must fit perfectly close to each other. If possible heat the surfaces before a fire; at any rate, they must be quite dry. Apply the glue to both surfaces, and remember that glue holds best when applied hot. *Use as little glue as possible,* but cover the two surfaces quite over. Do the work quickly, and bring the surfaces together while the glue is still steaming hot. When they have been brought together, hold them so for a few moments, till the glue is well cooled; after this do not attempt to disturb the joint again. Put the work aside in a dry place, and if possible in a warm place (should the weather be cold), in such a way that the joint will be absolutely free from strain; and let it rest for 24 hours. The work is then done, and if it be well done the wood will break before the

glue will give. After two articles have been glued together, and before the glue has quite cooled, it will be well—if it can be done without disturbing the joint—to press them together in some way, and keep the pressure on till next day. This may sometimes be done by a clamp, sometimes by a heavy weight, and often by tying firmly with a piece of cord.

Although it is best to have a proper glue-pot, glue may be melted, as has been already said (p. 23), in any small pot; but the fire must be slow, and care must be taken that the glue is not burnt.

To glue two boards along the edges (so as to form one continuous board).—Plane both edges perfectly straight and square, so that when placed together no light can be seen between. Fix one board edgewise very firmly, either by means of the bench-screw or by one of the plans already described (p. 38), or by any other contrivance, with the edge to be glued turned up. Apply the hot glue very quickly to both edges, and instantly turn one edge down on the other. Rub the edge of the loose board backwards and forwards on the edge of the other till they begin to stick; then let the joint stand till dry.

If the pieces be long, it will be much better that the work of lifting the loose board to its place, and rubbing the one edge on the other, be done by two persons, one at each end. Glued joints of this kind are often strengthened by dowels (for which see below); but if the gluing be well done, the joint will be quite firm without dowels.

Dowelling.

A dowel is a round pin or plug of wood—generally hard wood—and is very often used in carpentry. Dowelling is joining together two pieces of wood by pinning them with dowels.

To dowel-joint two boards.—Suppose you want to dowel along the edges two boards 3 feet long, 7

inches wide, and 1 inch thick. Two holes must be made in corresponding places in each of the edges to receive the dowels.

Choose the edges that are to be joined; they should, of course, be planed perfectly straight and flat, so that when put together you cannot see light through. Place the boards lying flat on a bench or table, one down on the other, the ends together, and the two edges that are to be joined together also—now forming one double edge two inches thick. At the two places where the dowels are to be—say 6 inches from the ends—draw with square and pencil two lines across the double edge; then separate the boards.

Now with a compass mark the centre of each of the four pencil lines, and make a shallow hole with a very small bradawl—make it very exactly at the centre—to serve as a guide for a gimlet or centre-bit.

With a gimlet or a brace-and-bit, make four holes —a $\frac{3}{8}$ or $\frac{1}{4}$-inch bit or gimlet will answer here. They must all be the same depth—say $1\frac{1}{4}$-inch; to ensure this, tie a bit of wood on the bit or gimlet, $1\frac{1}{4}$ inch from the top, to serve as a guide. Slightly countersink the four holes with a penknife or chisel (p. 11), to prevent the edges rising up, which would keep the boards from closing in.

Make four dowels of beech or ash, a little shorter than $2\frac{1}{2}$ inches, say $2\frac{3}{8}$: let them be a pretty tight fit, but not too tight, or they may split the boards; and round off the ends a little. It will be useful to heat the two dowels well, just when the joint is about being made, and to heat also the edges of the boards. Put glue all along on the edges of the boards, on the dowels, and in the holes: a quill feather is best for the dowels and holes; use very little glue. Insert the two dowels in one of the boards, but do not drive home; then insert both together into the other board, and drive home with a mallet or heavy hammer (see Fig. 26). If it is necessary to protect the edges

of the boards from the hammer, hold a thin bit of board on the edge to receive the blows.

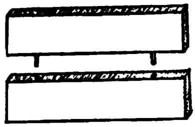


FIG. 26.

If the flat faces of the boards be not perfectly flush after the joining, make them so with a plane on both sides. There may be in this joint three or more dowels if thought necessary.

Dowelling is used in various other ways; but the dowel-joint above described is a good type of all.

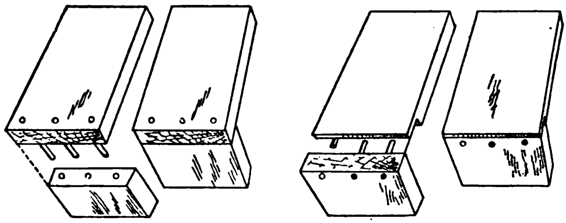


FIG. 27.

Two other applications are seen in Fig. 27. The way of making these will be obvious from an inspection of the figures.

Joining boards along the edges so as to form one continuous board.

One way of doing this has been described in the section on gluing (p. 46); another in that on dowelling (p. 46-7); and two others will be found in Chapter ix.—("Drawing-board" and "Ledge-door"). There are others more complicated which need not be described here, as the amateur, in all probability, will never have to trouble himself about them.

Mitre-jointing.

If two pieces are cut at half a right angle at the two ends, so that when these ends are joined the pieces will be square (or at right angles) with one

another, this is called a mitre-joint. Fig. 28 shows a plain mitre-joint. Picture frames are generally mitred.

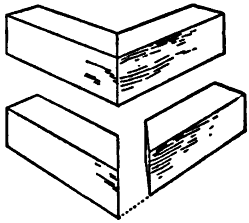


FIG. 28.

The pieces must be cut very exactly at half a right angle (or 45°), for if they are not so they will not stand square when joined, or when they are made to stand square the joint will not be close. To cut the pieces at that exact angle, is the chief difficulty of this sort of jointing.

To mitre-cut the pieces.—*Mitre-cutters.*—There are mitring machines for this purpose, of various patterns and prices. You have only to place the piece in its bed in the machine, and by moving a handle which carries a knife, the end is cut across at an angle of 45°. One small simple mitre-cutter is sold for 3s. 6d.; it will cut pieces about 2 inches wide and under, and it is very convenient for picture framing. It consists of a sharp chisel placed in a cast-iron frame at an angle of 45°, movable only along its length. The piece to be cut is placed in a bed made to receive it, and by a few vigorous cuts of the chisel the end is cut across at an angle of 45°.

Mitre-boxes.—But one may mitre-cut very well without any of these machines by means of what is called a mitre-board (or mitre-block, or mitre-box), which has an arrangement for guiding a tenon saw at an angle of 45°. The figure in Chap. ix. (see "Mitre-box: how to make"), shows the best form of mitre-box. The two pieces AB and CD are screwed down to a board, so as to have between them a groove with parallel sides. Two saw cuts, CG and DH, are made in the two pieces at angles of 45° with the sides.

A full description of the way to make this mitre-box will be found in Chap. ix.

To mitre-cut by means of the mitre-box.—Place the

piece to be cut lying along in the groove between the pieces and up against one of them with the part to be cut in the proper place. Hold the piece firmly against one side with the left hand and, placing the saw in one of the guiding kerfs, cut the piece across.

Observe: the pieces must be cut with a fine tenon saw. This will leave the cut surfaces slightly rough, which will make them take glue all the better, and will not interfere with the closeness of the joint.

Shooting-block.—Pieces may be mitre-cut also with a shooting-block, (see Fig. in Chap. ix. "Shooting-block: how to make"). Two boards are got, one wider than the other, and the narrow one is screwed down on the other so as to leave a sort of step, FG. Two laths, AE and AD, are screwed down on the narrow board so as to form angles of 45° with the edge CB. (For the way to make this see Chap. ix.)

To mitre-cut by means of the shooting-block.—First cut the end with a saw as near as possible at 45°, directed merely by the eye. Then place the piece lying flat on the upper or narrow board of the shooting-block, with the edge along the piece EA, and the cut end very slightly projecting beyond the point A, so that the saw cut will be parallel to CB. Place a jack-plane or trying-plane lying on its side on the flat part FG, with the iron turned towards the end of the piece to be cut. While the left hand holds the piece firmly against EA, work the plane with the right hand from C to B, so as to take shavings off the end of the piece: this will cut it at exactly half a right angle. Be very careful not to take shavings off the edge CB of the mitre-board itself.

To make a Mitre-joint.—The two pieces to be jointed must be of the same width. Mitre-cut the two ends to be jointed either with a machine or with a mitre board or shooting-block. Observe, if the two edges of the pieces be different (as in most picture frame mouldings), the pieces must be mitre-cut in such a way that when the cut ends are put together

the similar edges will be matched. To do this, when you mitre one end by means of the cut CG of the mitre-box or by the guidance of the piece EA of the shooting-block, you must mitre the end to match this by means of the other kerf of the mitre-box, or by the guidance of the other piece of the shooting-block (that is, supposing the pieces are lying, while cutting, with the same face up). If there is any difficulty in understanding the reason of this from the present description, it will be understood the moment one takes the pieces in hand to cut and match them.

The ends must now be nailed together. A vice or cramp specially adapted to the purpose is sometimes employed, which holds the pieces firmly together while the hole is bored and the nail driven home. A cramp to take $1\frac{3}{4}$-inch moulds and under will cost 2s.; $2\frac{3}{4}$ inches and under, 3s.; and 4 inches and under, 5s. The best nails to use are wire nails; but any slender nails, such as hook-heads or battens, with the heads taken off, will answer quite well. The nails must be suited in size to the thickness of the pieces to be jointed.

Tradesmen, when making a mitre-joint, hardly ever use a cramp; they work quite correctly without it, and an amateur may learn to do the same. Place the pieces together, as shown in Fig. 29, with the corner of the piece that is first to receive the nail a little beyond the corner of the other, to allow for the displacement caused by hammering. Bore a deep hole quite through the first piece and well into the second, almost as deep as the length of the nail. Hammer the nail home: the hammering will bring, or should bring, the two corners together. How far one corner is to be placed beyond the other will be learned by a few trials.

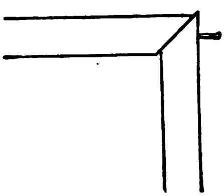


FIG. 29.

A mitre-joint will generally require two nails. Some-

times the two nails are driven at right angles to one another, one from one side of the corner, and the other from the other side.

Observe, however, a plain mitre-joint like that shown at page 49, may be made without the aid of either mitring-machine or mitre-block in the following way:—Line out the ends to be cut in the first instance, so as to show exactly the wood to be removed; then cut *near* the lines with a saw, and pare accurately with a sharp chisel. The manner of lining out will be obvious to anyone who examines the manner in which the pieces are to be put together.

To mitre-joint two boards at their edges.—Boards are often joined at right angles (like two adjacent sides of a box) by a mitre-joint.

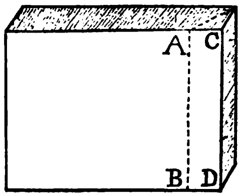


FIG. 30.

To bevel the edge of a board for this joint, draw the line AB (Fig. 30) at a distance AC *exactly* equal to the thickness of the board. Plane off (with a jack-plane) the angle CD as far as the line AB, and as far as the other angle (exactly as far, but no farther). This must be done with great nicety, with very little iron as you come towards the end of the work. If the bevel is across the grain, as it generally is, the plane must be very sharp, and you must plane from both ends towards the middle.

When two boards are bevelled in this way they will stand exactly at right angles when the bevelled ends are placed together in the proper way.

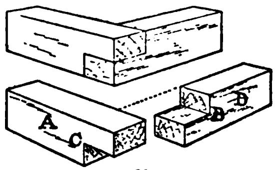
Glued tongues.—The bevelled edges are glued together: but it is usual to strengthen the joint after gluing by some other mode of fastening, such as nails, screws, or dowels. A common mode of strengthening a mitre-joint like this is by glued tongues. Cuts of a proper depth are made with a saw into both pieces at the joining, either at right

angles to the joining or a little oblique. Into these cuts thin slits of hard wood are fitted pretty tightly, and fastened in with glue. After the glue is well dried, the slits are smoothed off flush with the sides of the board.

Another common way of fastening such a mitre-joint as the last, is to glue square-cornered bits on the inside of the angle: but this method has one disadvantage, that the bits are in the way, and make the joint clumsy.

Halving together.

To make a halved-together joint (or as it is sometimes called a *half-lap* joint). This joint is represented in Fig. 31.



31

The two pieces must be accurately squared up (see "Squaring up"). The parts to be cut away are first to be lined out. The length of the part to be cut from D, will be the same as the width of A; and the length of the part to be cut from A will be the width of D (but both lengths may be marked out slightly in excess to allow for paring). The thickness of the parts to be cut away will be half the thickness of the two pieces.

Mark with a compass the points B and C at the proper distances from the ends, and at equal distances from the sides. Using the square, draw pencil marks half round; and draw also the remaining lines round the parts to be cut out. These marks may be made either with a pencil and ruler or with a gauge. Some of the lines now marked on the pieces are across, and others along the grain.

Cut the marks across the grain with the point of a sharp penknife, using some pressure on the blade, so as to cut into the wood.

With a fine tenon-saw make a cut along the knife marks: cut close to the marks, but so as not to touch or remove them: cut down to the marks along the grain, i.e., half way through. Then again, cut along the grain, well inside the marks; and remove the core.

When the two cores have been removed, clean out the superfluous wood with a very sharp chisel, taking great care not to injure the edges. When this is well done, the two parts will exactly fit, and the surfaces will be flush. The two pieces must be fastened together by dowels or screws, assisted by glue.

A halved together joint has not much strength; but it is often used when the pieces are too thin for tenon and mortising.

Splicing or Scarfing.—There is a kind of halving-together commonly called scarfing or splicing, in which the two pieces are joined, not at right angles, but in the direction of their length.

There are several forms of splicing, three of which are represented in Fig. 32. The way of cutting the pieces for a spliced joint is evident from the figures. If the scarfed beam or rod has to bear a strain in the direction of its length, A and B are stronger than C: if the strain be across, as in a fishing rod or brush handle, C is stronger than A, and A stronger than B.

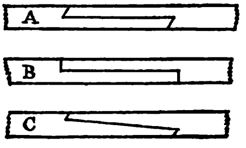


FIG. 32.

The length of the splice should be about six times the diameter of the pieces. The two pieces must be fitted very exactly, and may be fastened together with screws—if they will admit of screws: it will be better to drive the screws alternately from opposite sides. The pieces are sometimes fastened together by twining waxed cord round them the whole length of the splice, either with or without screws. The amateur will be able to determine which is best for the particular job—screws, or waxed cord, or both.

If a fishing rod, a brush-handle, a roller of a blind, or any such article get broken across, it may be spliced so as to be almost as good as new.

Coiling with cord or wire.—If such a thing as a brush-handle be broken, not right across, but so that the fracture runs for four or five inches from one side to the other, it may be secured by merely tying it up with waxed cord wound round and round the whole length of the fracture. If it is thought undesirable that the cord should rise over the surface, a bed may be sunk for it; the best tools for this purpose being a penknife and rasp. But remember that this weakens the joint.

Whenever waxed cord is wound round a splice or fracture, if it is desirable that the work should be very neat and smooth, the cord called fishing twine should be used, which is very strong, smooth, and hard; or a cord made of silk thread

It will make the whole thing more smooth, and more secure, if the cord, after it is wound on, be brushed over with thin glue, which will soak in and harden the cord when dry.

In winding a cord round a stick in this way, the first end is fastened by doubling it under the coils—or by putting it through a hole in the stick, as is done with wire (see next page). The last end is fastened in the manner shown in Fig. 33. When within five or six coils of the finish, put the end of the cord down on the bed in such a way that the remaining coils will go over it, but leave as much of the extreme end free as will give a good hold. Finish the coils, and while holding the last coil tight with the left hand, take hold of the end of the cord with the right, and pull it through till it is quite tight.

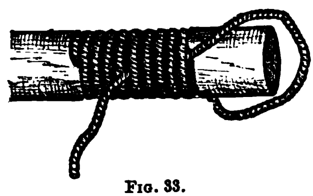


FIG. 33.

Sometimes copper wire is used instead of cord: in this case a bed should generally be sunk for the wire. To start the work, make a small hole in one end of the bed right through, just large enough to take the end of the wire by a little forcing. Put the end through so that it will project an inch or so beyond; and bend that end down on the bed, cutting a little channel for it. Then begin the winding, pulling tight all through: the coils will cover the end that has been bent down on the bed. At the finish, pierce another small hole and pull the wire through tightly, if this does not seem secure make another hole and pull through: then cut the wire.

The last end of a coiled copper or brass wire may be fastened like cord, in the manner shown in Fig. 33: but here it will be necessary to make a little channel for that part of the wire which is to run under the coils, else there will be an ugly ridge or projection.

If brass wire be used, it may be softened by heating till it is a dull red, and then throwing it into water; it will then be almost as soft and pliant as copper wire.

Copper wire is 1s. 6d. per lb.; brass wire, 1s. 4d.; better buy both kinds by weight than by pennyworths.

This is as good a place as any to mention, that if you make a handle for an awl, a file, a chisel, &c, the end which is to hold the shank should be bound with twine or copper wire in the manner described above, before the hole is made for the shank. This will preserve the handle from splitting quite as well as a ferrule.

Tenon-and-Mortise.

The joint shown in Fig. 34, is a tenon-and-mortise joint: the opening is the *mortise;* the tongue that fits into it is the *tenon.* This is an open tenon-and-mortise-joint.

The sides and ends of the pieces are to be cut and planed up perfectly square in the first instance.

The depth of the mortise in A will be the breadth of B: mark this by laying B down on A in the proper position, and putting a mark across the grain of A, directed by the side of B. By means of a square, carry this mark round the four sides of A. In like manner put a mark round the four sides of B, at a depth equal to the width of A. In both cases leave a slight excess to allow for paring afterwards.

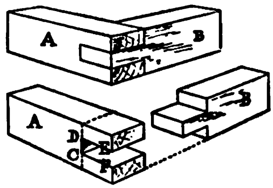


FIG. 34.

With a compass divide the thickness of A at D and C, into three equal parts: and draw with a gauge, or with a rule and sharp point, lines DE, CF, through the dividing points along the side, as far as the end. Continue these marks along the end and along the far side. Line out B exactly in the same way.

One core has now to be removed from A, which is to be done with a tenon saw, or any fine saw, and a mortise chisel, or any strong narrow chisel. Make the saw-cuts first, and keep close to the lines, but well inside, so as not to cut into them.

In using the chisel, keep the flat side towards DC (the closed end of the mortise), and cut near the line DC, but so as not to touch it. Use a mallet, and cut with the chisel from both sides of A, till the two cuttings meet in the middle. When the core has been in this way roughly cut out, clean the mortise exactly to the marks with a sharp chisel. There are now two pieces to be cut from B, which is done altogether with the saw (like the core of a half-lap joint p. 53), after which clean with a chisel.

The cleaning must be carried on till the tenon fits tightly into the mortise (but not too tightly, else A might split); and if the work is well done, the shoulders of B will fit up close to the side of A, and the several surfaces will be flush. If not quite flush after

the joint is finished and fastened, make them so with the plane. The joint is fastened with glue, and with dowels or screws if necessary.

Figure 35 represents a closed tenon-and-mortise joint. To make this joint. The tenon on B is made in the same way as the tenon of B, Fig. 34 : it should be about $\frac{1}{3}$ of the whole thickness.

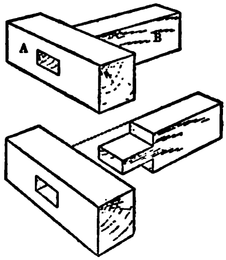


FIG. 35.

To make the mortise in A. Mark with a pencil in the proper place on one side of A, the *length* of the mortise: this length will be equal to the width of the tenon of B. Using the square as guide, draw two pencil lines through the marks across the side: still using the square, carry these two lines round the four sides of A.

On each of the two opposite sides of A—that is, of those two sides that are to be pierced—draw with a gauge, or with a rule and sharp point, two lines along the length, marking the width of the mortise, which must of course correspond to the thickness of the tenon: this completes the lining out of the mortise at both sides.

To remove the core.—Use a mortise chisel a little narrower than the width of the mortise. Place the chisel standing perpendicularly with its edge across the grain, within $\frac{1}{8}$-inch of one end line of the mortise, and *with the flat side towards that line;* and cut down, using the mallet. Lift out the chisel and make another cut near to and turned towards the first, and dig out the wedge-shaped piece of wood: do this several times, still deepening the cut, and carrying it towards the middle. Do not attempt to cut out very big pieces.

Begin also from the other end line; *always keeping the flat side of the chisel turned towards the near end of the mortise* (and of course the bevel side

towards the middle). Cut in this manner till the mortise is about half way through. (Instead of working from the two ends of the mortise towards the middle, some would begin in the middle and work both ways towards the ends).

Then turn A over, and cut down in the same way from the other side, till the two cuttings meet. The core is then removed. Finish with a sharp chisel till the tenon fits tightly into the mortise. It must not fit so tightly as to require much force or the wood may split.

Another way of removing the core.—First make a cut all round the mortise line with a chisel at both sides. Then with an auger or brace-and-bit bore several holes between the mortise lines and nearly the full width of the mortise, after which clear out the superfluous wood with the ordinary chisels.

Fig. 36, represents a closed tenon-and-mortise joint, double along the length. This joint is often used where the piece that is to be tenoned is very wide in proportion to its thickness. The four vertical pieces of a table (the pieces on which the top leaf is fixed) are often jointed into the legs in this manner. So also with the four vertical pieces of a common wooden bedstead.

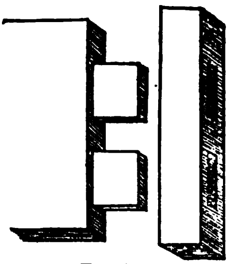


FIG. 36.

A closed tenon-and-mortise joint is often fastened with one or two wedges, driven into the end of the tenon. The manner of doing this will be obvious from Fig. 37. It may be done in any one of several ways: in A there are two wedges, one at each end of the tenon: in B one wedge in the middle of the tenon: in C one wedge driven diagonally. The opening for the wedge is

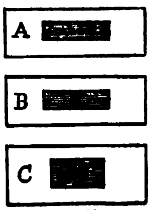


FIG. 37.

made with a chisel; and if the wedge is sound and not made with too large an angle, it will force its own way deeper than the chisel opening. These wedges are sometimes used with glue, and very often without it.

Dovetailing.

In the open tenon-and-mortise joint, Fig. 34, p. 57, the tenon is the same thickness throughout, and the two pieces may be separated by either pulling A in its direction or pulling B in its own direction. But in a dovetail joint, Fig. 38, the tenon—or the *pin* or *tongue*, as it is called in this case—is thicker at one side than at the other; and consequently the pieces can be separated by pulling or forcing in one direction only. In a dovetail joint, the opening is called the *socket*.

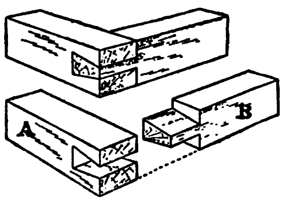


FIG. 38.

If there is only one tongue and one socket, the joint is a *single dovetail*; if there are several it is *compound*.

To make a single dovetail joint.—Square up accurately the parts to be jointed. The tongue must first be made: suppose it is to be on the piece B. Its length will be equal to the depth of the piece A (but allow a little excess for paring, as in the tenon-and-mortise).

Line out the tongue: this will present no difficulty to anyone who can line out an ordinary tenon. The two oblique sides may form any reasonable angle. Cut out the parts to be removed, and pare the tongue accurately up to the marking lines.

Now up against the side of A, where it is to be pierced, put the end of the tongue, and mark out its shape with a sharp pencil. Taking this as a guide

and using the square when necessary, line out all round the part to be cut out.

Cut out the core with a tenon saw and a mortise chisel; after which clean out with a chisel till the tongue fits moderately tightly. A dovetail joint is fastened with glue.

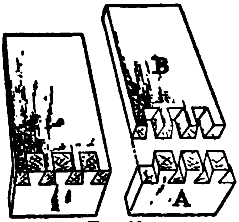


FIG. 39.

To make a compound dovetail joint—(Fig. 39). The thickness of A is to be marked off from the end of B, and the thickness of B is to be marked off from the end of A: this is done with a gauge, or with a straight edge, compass, and pencil. The distances marked off in both cases should be very slightly in excess to allow for paring.

Now shape out the tongues on A. There is no general rule for this: each workman determines the number, size, and angle of the tongues. Only observe, first, the tongues should be equidistant; secondly, all should be made to the same angle. The angles may be drawn with a bevel; or when the first tongue has been marked out, cut a bit of card exactly the size and shape of its side, and use this as a gauge to mark the others.

Then, having lined out all the tongues and sockets as in the single joint, cut out the cores of A with a saw and chisel, and clear out the sockets with a chisel till the tongues are perfectly formed.

Next put the sides of the tongues against the end of B, and with a pencil mark out all the shapes. Line out all the tongues and sockets in B, cut out the cores, and clean out the sockets, till the several tongues and sockets fit each other with moderate tightness—not too tightly or there may be a split. Glue the pieces together, and when the joint is quite dry smooth away all roughness or projections with a very sharp plane and sandpaper.

The joint represented in Fig. 40, is a lap or half-blind dovetail joint. After what has been said, a mere inspection of the figure will be enough to suggest the way to line out and make it. This joint is used for drawers. The piece B will be the front of the drawer, and will be furnished with handles, and the pull will be in the direction of the arrow, so that it will be impossible to loosen or pull away this front board, on account of the shape of the tongues. As the joint is half blind, the joinings will be altogether concealed from view when the drawer is shut. There is of course another dovetail at the far end of B.

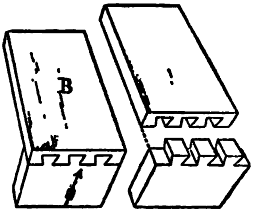


FIG. 40.

A dovetail joint should never be made except with well-seasoned timber. If the timber be fresh, it will shrink, and the joint will loosen.

CHAPTER VI.

NAILS AND SCREWS.

Nails.

Different kinds of Nails—Nails are of various shapes and sizes; and according to shape they are known by different names. Everyone knows the ordinary 4-penny nails, 6-penny nails, &c. (which are all hand-made). There are clout-nails with broad flat heads; battens or hook-heads, slender nails without heads, except a little hook-like, projection at one side; wire nails, which are made of round wire, and are the same thickness throughout, except the point; flooring-brads, which have no heads at all, &c.

Some nails are cut and some are wrought. Wrought nails are hand-made: they have sharp points and

will bear bending and clinching. Cut nails, as the name implies, are cut by machinery from sheets of iron: they are rough in make, and blunt at the point, are liable to break when bent, and except very slightly, will not bear clinching. Once they are driven home they have a better hold than wrought nails: they are also much cheaper, and should be bought for all ordinary purposes. They are made $\frac{3}{4}$-inch, 1 inch $1\frac{1}{2}$-inch, &c., up to 6 inches.

Bradding.—For certain purposes the heads of some wrought nails are too broad, so that they make too much of a break in the surface of the wood when driven home. To prevent this, the heads are often *bradded*, i.e. flattened by a few blows of a hammer. To brad a nail, the shank is held firmly between the thumb and fore finger of the left hand, and the head is laid flat on the side of a hatchet and struck with a hammer. If the head is not struck *square* the fingers will get a severe shock.

Driving Nails.—Except you are driving very small nails in soft wood, it is always better to make a hole, which will guide the nail more truly home.

When driving, you must strike the head *square*, i.e., exactly in the direction of the nail; and the centre of the face of the hammer must come on the head. If there is any inclination in the stroke—in other words, if the head is struck sideways, the nail will bend.

Strike very gently at first, and as the nail goes home, gradually increase the strength of the blows. In driving a nail the more haste the less speed: if you strike heavily at first, you are pretty sure to bend it aside.

But the best workman will sometimes bend a nail. If a wrought nail gets bent it will commonly bear straightening up, so that it may be driven home. But if a cut nail is bent it must generally be withdrawn, as it will not bear straightening:—that is, if

it is very much bent: for a cut nail slightly bent may be straightened. A claw-hammer is sometimes used to draw a nail: but it is not the best tool for this purpose, for reasons already given (p. 7): besides the hammer when used this way leaves a dint in the wood and will spoil nice work. The best tool for drawing a nail is a strong pincers.

Sometimes it is necessary that the heads of nails should be buried in the wood, which is done with a punch. If neat work is desirable, the holes over the heads can be filled up with hard putty (see "Putty").

To clinch a Nail.—Let the back of a hatchet or the face of a heavy hammer be held and pressed firmly against the head of the nail, while with a hammer you turn the point and bed it into the wood. Sometimes one man may do both, holding the hatchet in the left hand and clinching with the right: but sometimes this is impossible, and then one man must hold the hatchet while another clinches.

Prices.—Cut nails are sold for 2d. or 2½d. per lb. Wire nails 3d. per lb. 4-penny nails per 100, 3d.; 6-penny, 3½d.; 8-penny, 4d.; 10-penny, 6d.; 12-penny, 7d.; 20-penny, 10d.; 24-penny, 12d. Battens, clouts, &c., are about the same price as the several kinds last mentioned (4-penny, &c.), of the same sizes respectively.

Screws.

Driving Screws.—In many kinds of wood-work, screws are much preferable to nails; and they should be always used where the work may have to be taken asunder at any future time. Screws should be used to fasten hinges, locks, bolts, &c.—never nails.

In driving screws in soft wood, the hole for half the depth of the screw, or a little more, may be made quite as large as the screw; but for the remainder of the depth it should be something smaller: the screw will force itself nevertheless, and will then have a firm hold. This is done by first boring the entire

depth with a small awl or gimlet (smaller than the screw), and then half way with a larger one. The screw may be at first *hammered* in half way like a nail, and driven with a turnscrew the rest of the way.

In driving a screw in hard wood, the case is different: here the hole must be the same size all through, and must be only slightly smaller than the screw. If a screw is forced into too small a hole in hard wood, it is likely you will not be able to drive it home, and will have to withdraw it; or the screw is liable to snap suddenly, leaving a fragment in the wood and causing much trouble.

In screwing two pieces of wood together, the first piece, that is the piece bearing the head of the screw, may have a hole larger than the screw: the other piece—the one carrying the point—should have the hole smaller than the screw, in order to give a good hold.

In all cases the wood should be countersunk for the head of the screw (see p. 11): in hard wood this must be done neatly.

Sometimes in driving a screw well home, the thread formed in the wood itself breaks. When this happens, the screw has no hold and should be withdrawn, and a thicker one driven in. In withdrawing the screw, you have, of course, to turn the screw-driver the reverse way: but when the wood-thread is broken, though the screw is turned it will not come out. In this case get the edge of an old knife under the head and keep forcing the head out with it while the screw-driver is turned; once the head is withdrawn far enough to be caught by a pincers, the thing is easy enough.

When you are putting a new screw into an old screw-hole, the new screw must be a little thicker than the old one. But sometimes the old hole is so much worn that it has to be plugged. It may be plugged with a bit of soft wood dipped in hot glue,

Another way is to drop in hot glue, and then fill tightly with a plug of good cork: make a hole in the centre of the cork and screw home. Either plug may be used without glue, but the grip will not be so sure.

Screws should never be wetted before being driven; as for instance, by putting them in the mouth, as many do. This causes them to rust, which will make it difficult or impossible to withdraw them—if at any future time this becomes necessary. If they are dipped in grease or rubbed with common blacklead, it will help to keep off rust, and make their subsequent withdrawal all the easier: besides, it is easier to drive them.

To draw old Screws.—It is often necessary to withdraw old screws, as when a hinge breaks, or a lock gets out of order. This may, in most instances be done by firm pressure with the turnscrew. But this sometimes fails. You must then try to start the screw by placing the edge of the turnscrew obliquely against the side of the groove at one end of it, and striking a few smart decided blows with a mallet—the turnscrew being placed of course so that it will tend to turn the screw backwards. Once it is started the least bit the rest is easy.

But this sometimes fails—if the screw is very old and rusty—and then there is no other course but to force the screw by hammering in the point of a chisel or turnscrew underneath. This always causes fracture and more or less injury to the wood-work. If several screws near each other—as in a small hinge—have to be withdrawn, start and take out all you can at first, leaving the refractory ones to the last. If you fail with one or two, this makes the injury to the wood-work as little as possible.

Sizes and Prices.—Screws are of various lengths, from ⅛-in. up to 9 inches. Each length has several *numbers;* the number referring to the thickness. The same number means the same thickness in all screws.

Iron Screws.—Half-inch screws, or any shorter, are sold for 4d. a gross. Three-fourths inch, from 5d. to 7d. a gross, according to *number.* One inch, from 6d. to 9d. a gross. Two inch, from 1s. 2d. to 2s. 6d. a gross. Six inch, about a 1s. a dozen. Nine inch, 1s. 9d. a dozen. These few specimens will give a good idea of the prices of screws of all sizes and numbers. If the smaller screws are bought by the dozen, they will cost a good deal more in proportion. Thus screws that may be bought for 7d. a gross will cost probably 1d. a dozen.

Of brass screws, it will be enough to say that they usually cost something more than three times as much as iron screws of the same size.

CHAPTER VII.

LOCKS, HINGES, AND BOLTS.

Locks.

Different kinds.—There are many different kinds of locks, of which the most common are *box locks, cupboard locks, drawer locks, door locks,* and *padlocks.* All these have in their interior one or more circular plates, called *wards,* with spaces between. There are corresponding wards with spaces or notches between in the key, so placed that the solid parts of the key move in the hollow spaces of the lock, and *vice versa;* and as the wards of the lock are circular, the key can move round without interruption. As a general rule the more wards there are the better the lock and the more difficult to pick, provided there are corresponding wards in both lock and key.

The old form of lock is what is called the *ward and spring* lock; this is a cheap lock and is still

much used. But there is a better kind called the *tumbler* lock, which is more expensive; and a still better and safer lock, and still more expensive, the *lever* lock. Some locks are made of iron and some of brass, the latter being of course the more expensive.

A Box Lock.—I shall take a box lock as a type to represent all, and describe in detail how to put it on. Box locks are for boxes, trunks, chests, and desks. The lock itself is fixed on the edge of the box or desk, and a catch is fixed in the corresponding part of the lid above.

Fig. 41 is a sketch of a box-lock. There are five parts in this lock which we must know by name: 1, the main plate AA; 2, the top plate BB, which is a continuation of the back plate, bent at right angles (seen here edgewise); 3, the box CC, which in good locks is screwed on to the main plate, but in cheap locks is merely riveted, and which contains within it the wards, springs, &c.; 4, the bolt DD (in this case a double bolt, both the parts seen being portions of one large bolt); 5, the spike E, which is fixed at right angles on the main plate, and enters the tube or barrel of the key. Locks are usually designated by the length of the top plate BB, as 2-inch locks, $3\frac{1}{2}$-inch locks, &c.

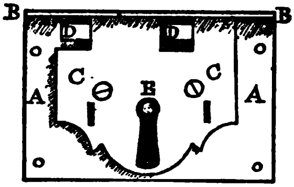


FIG. 41.

To put a box lock on a common trunk or box. A bed has first to be sunk in the middle of the edge of the trunk to receive the top plate. Remark:—the width of the top plate should be a little less than the width of the edge on which it is to rest, so that the bed will not extend quite across the edge, and the edge of the top plate will be hidden by the bit of wood left on the outside. The bed

should be sunk so deep that the surface of the top plate will be flush with the surface of the edge—*but no deeper.*

Put the lock in position, with the top plate level with its bed, and the top of the spike against the inside of the box: strike the lock smartly, so that the point of the spike will leave a decided dint on the inside of the trunk; remove the lock and bore a hole through the dint, quite as large as the spike. Be very particular that this hole is in the right place.

Put the lock in its place again with the spike through the hole as far as it can go: the box of the lock is now against the side of the trunk: mark with a pencil the exact size of the box on the timber (or if there is any difficulty in doing this, measure the size of the box all round the hole and mark it). Remove the lock, and sink a bed for the box, so deep that the main plate will come against the timber, but no deeper. Do not make the bed a bit broader than the box, or there will not be timber enough left to hold the screws. Some would also sink the main plate into the wood: this may be done for neatness, but it is not necessary.

To make the keyhole.—Put the lock in its place: the spike will now come nearly or quite through. Put the key in its place, with the barrel at the top of the spike, and mark its exact size on the wood; then remove the lock. A hole has been already bored at the top of the space to be occupied by the keyhole: bore another at the bottom, and clear out the intervening wood. The wood is best cleared out by running a cut with a pad saw from one hole to the other, and cutting out the rest with a penknife. But it can be altogether cut out with a penknife without any pad-saw.

After this the key-hole will have to be very carefully enlarged to fit the key. For an amateur, by far the best tool for this is an old penknife with the blade well worn—but to be of any use it

must be kept sharp. Keep paring the inside of the keyhole wherever wanting, testing it every now and then by holding the lock in its place with the left hand, and trying with the right whether the key will act. A rat-tail file (p. 18) is a very useful tool for this work. When at last the key can be freely inserted and withdrawn, and locks and unlocks, the lock may be screwed up. The screws should be as small as possible, consistently with holding the lock on firmly.

To fix the catch.—The catch has now to be fixed on to the front edge of the lid. On the top of the catch-plate there is always a sharp point as seen in Fig. 42. (and sometimes two or more). The use of this will now be seen. Put the catch down on the lock, with the loop, or loops (for there are often two, as in Fig. 42), in their places down in the lock, and turn the key so as to fasten the catch.

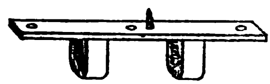


FIG. 42.

Now shut down the lid smartly; and the point of the catch will sink into the edge of the lid when it comes down. The point sinks so deeply into the wood that the catch (having been first released from the lock) will come away with the lid when the latter is raised. This will enable you at once to mark out the size of the catch-plate in the proper place on the edge of the lid. Sink a bed for it, so deep that the surface will be flush with the surface of the edge, *but not deeper.*

Screw the catch into its place in the lid: the probability is that the lock is now all right, and that you can lock and unlock quite freely. But if there is any obstruction, it shows that the catch is not quite rightly fixed, so that the two parts of the bolt beneath, instead of going through the loops, strike against them at the right hand side. If this be the case, the spots where the bolt strikes may be found by smearing

some soft substance, as soap, or a mixture of soap and a bit of wax candle, in the loops of the catch, shutting down the lid, and shooting the bolt as far as it will go: then, having withdrawn the bolt, lift the lid, and the spot or spots where the bolt has struck will be seen by the mark left in the soap. This will at once show the side of the catch-plate that requires to be raised; which is done by withdrawing the screws and inserting underneath, in the proper place, a bit of leather, or several folds of brown paper.

I have often freed a lock caught in this way, not by disturbing the catch, but by filing the loops on the inside with a small file, so as to enlarge them at the proper places.

On the outside of a keyhole there is generally a small brass guard called an escutcheon, either *let in* or *tacked on*, with a keyhole cut in it of the proper size. An escutcheon is always given with the lock without any additional charge.

Cupboard Lock.—A cupboard or press lock has no top plate: it consists of one rectangular plate, with box, one large bolt, and spike. It is screwed on to the left edge of the right-hand shut, so that the edge of the lock will be flush with the edge of the shut. It is usual to sink a bed in the shut to receive the plate. There is usually a catch screwed on to the middle shelf to receive and hold the bolt, so that you can lock the right-hand shut while the left hand shut remains open. But when both sides are closed, and the key turned, the left shut is kept in its place by an overlapping rabbet on the right shut.

Sometimes there is no catch, but the left shut is held in its place by a hook fixed in a shelf which catches an eye screwed into the shut: the hook is first shot into the eye, and then the right shut is closed and locked.

Door Locks are either *mortise locks* or *rim locks*. A mortise lock, which is generally used for the doors of sitting-rooms, is inserted into the substance of the

door, not adding to the thickness: a rim lock is screwed on to the back of the door at the edge, adding so much to the thickness. When rim locks are made large, as for hall-doors, they are called *stock locks.* Door locks are either left handed or right handed, according to the side of the door that opens; and in buying a lock, this must be kept in mind. But a left-hand lock can be put on a right hand door, or the reverse, by merely making the keyhole upside down.

The case in which an amateur is likely to have to take off or put on a door lock, is when the old lock gets out of order, and has to be examined. Then the lock is either mended, or if it is hopelessly broken or worn out, rejected for a new one.

To remove a mortise lock.—Take out the key; take off one handle by withdrawing the binding screw (which will be found in the thin part of the handle); then pull out the other handle, which will bring with it the square bar that goes through the door. Withdraw the two screws that bind the plate of the lock at the edge of the door. The lock can now be drawn out by inserting the point of an awl or turnscrew under this plate. These locks are made to gauge; so that if a new lock is necessary, one the very same size can be bought, which can be easily inserted and screwed on, and the handles restored. Sometimes the handle of a parlour door lock comes off on account of the binding screw falling out. It is easy enough to restore the handle and drive home the binding screw tightly: or if the screw be lost a new one can be got at the hardware shop for a halfpenny or less.

As for the rim lock, it is so easily taken off and put on that no description of the manner of doing so is necessary. I have only to remark, that when a new lock is bought, it should always correspond in size with the old one, otherwise a new keyhole would have to be made, and perhaps the staple removed.

Whoever understands the management of box and door locks will have no difficulty whatever in taking off or putting on a cupboard or drawer lock.

Locks out of order.—It is generally quite easy to take a lock asunder, whenever it becomes necessary to examine the interior. You have only to look at the outside of the lock and you will observe the screws that bind the box, or body, to the main plate; there are two such binding screws in the lock, Fig. 41. When these are withdrawn (which will require firm pressure of the turnscrew) the front plate CC of the box can be taken off. Now use the key, turning it both ways several times, and the machinery will be quite plain, and the fault or fracture, if if there be one, will likely appear. It is not quite so easy to restore the removed plate, and drive home the screws; but it is easy enough. Very cheap locks are put together with rivets instead of screws, and it is more difficult to take them asunder.

Locks get out of order in many ways, but in by far the greatest number of cases, it requires only a little head and a little handiness to set them right.

If the key will not turn at all, examine the barrel with a pin hooked a little at the point, to see whether dust has lodged in the bottom; if so, clearing the barrel will free the key.

Sometimes the key will not turn beyond a certain point, or turns with difficulty: this is a sign of something wrong. Use no force beyond gentle pressure: forcing would only make matters worse by breaking the key or some of the wards of the lock. If the key does not turn after a few trials, either the lock or the key is in fault. Examine the key first: one or more of the wards may be found to be bent by a fall or some other accident. When the ward is straightened, the key will most likely work all right. But there is a danger here. If there be the slightest crack in the straightened ward, do not venture the key in the lock again, as it is pretty sure to break. The key must in this case be brazed or renewed.

If, on examination, nothing is found wrong with the key, then take off the lock and open it. Perhaps a pebble, or a bit of wood may be found wedged among the wards. But more likely one of the wards will be found bent—a matter easily remedied with a pliers. If, in bending back a ward, a piece of it breaks off altogether, this may do no harm, provided the rest of it is in the proper position, so that the key may move smoothly round. Try if the key will act before screwing up the lock again.

Perhaps one of the springs may be found to be broken: in this case the old spring must be taken out, and a new one got, of the same size. Lock springs are sold in most good hardware shops at from 1d. to 3d. Of course, if a spring cannot be got, the lock must be sent for repairs to the locksmith.

Sometimes the obstruction is caused by the breaking of the key itself, a bit of which remains in the lock. Having taken off the lock, try to get at the bit by shaking it out through the keyhole: if this does not succeed the lock must be opened. A new key must now be got: the old key with the bit should be sent as a pattern: or better, send both lock and key. A very common cause of the breaking or bending of a key, or the breaking of a ward of the lock, is using a wrong key in mistake and trying to force it. This is a proceeding pretty sure to do damage.

Occasionally when the key breaks in the lock, it will turn neither way and cannot be got out: this is generally a cross business. If it be a door lock, take off the lock and open it: this usually frees the key. If if be a box lock or a cupboard lock, and that, while the key refuses to turn either way, the lock is open, take off the lock. But now you have the lock at one side of the keyhole and the key-loop at the other, with the key through.

Perhaps the key-loop may pass through the keyhole: if so, the rest is easy enough. But if not, you

must manage in one of two ways. *First*, take the lock asunder, which will free the key. But on account of the awkward position, you may not be able to get at the screws: in this case there is nothing for it but, *secondly*, to cut off the key-loop with a file. After this, either a new key has to be got, or the old one will have to be mended and brazed.

The case is still worse if the box or press is locked while the key is in and cannot be got to turn. Try turning the key gently one way, and then the other, while you keep striking the lid or shut with the side of the fist, so as to shake the lock well. I have seen a key freed by this plan. If the key comes out do not venture it in again till you examine both key and lock. If, on taking out the key the press is open, things are on the fair road: but if not, proceed as if the key were lost (see below).

If a *box* or *desk* is locked while the key is in and cannot be got out, the lock must be forced. But if this happens with a *press* or *cabinet*, try whether a board or two can be removed from the back: the lock can then be got at from the other side, and the screws withdrawn. Failing this, the lock must be forced.

If the key is lost while the press is locked, the best plan is to pick the lock, if it can be done. Locksmiths can pick most ordinary locks; and a mere amateur may often do the same with a piece of strong wire bent square at the end, so as to have something like the shape of a key. If the lock cannot be picked, the plan of taking out the back of the press may be tried. Often in a case of this kind several keys might be tried resembling the one lost: but use no force or the strange key might be strained or bent. If the lock cannot be opened in any way it must be forced.

When about to force a lock, examine carefully as to the best way of going about it. Sometimes a strong

knife inserted between the shuts of a press at top and forced down gradually towards the lock will open it, without injury to the wood-work. By a little management a desk lock can also often be forced open quietly with a strong knife. But in most cases the forcing of a lock injures the wood-work, or lock, or both.

When a key is lost and the lock is open, unscrew the lock and bring it to the ironmonger's or locksmith's. In such places they keep great bunches of old keys, some one of which will generally be found to match the lock. If a key is found nearly, but not quite a fit, a few rubs of a small file may set it right. The place to file can usually be found by means of soap, as shown at pp. 70, 71.

Sometimes the key of a tumbler lock will stick half way in the turn, and will not turn one way or the other, even when there is no break or bend. Try the effect of striking smartly with the side of the fist, so as to shake the lock, while a gentle pressure is applied to the key, first one way, then, if need be, the other way.

In a drawer lock, this may be mostly set right in a very simple way. Insert the blade of a thin old kitchen knife in the slit above the drawer, and press the edge against the bolt. Now scrape the bolt strongly downwards, working to drive it back; or if this fails, work upwards to drive it home. If one knife will not do try two, one in each hand, taking the bolt at both sides. If you succeed either way the key is freed. I have always succeeded in freeing a drawer lock in this way.

The usual cause of this misadventure is some obstruction to the movement of the bolt. To avoid it, take care that the bolt has freedom to shoot home, and lock and unlock quickly, but without violence.

Sometimes a sittingroom or bedroom door, or the heavy door of a press, sinks by its own weight, and the bolt instead of shooting through the

opening in the brass plate or jamb opposite, strikes against the lower edge. Take off the brass plate and file the lower edge of the opening till the bolt has a free passage. Or screw on the plate a little lower down, and fill up flaws with putty, painted over.

Oiling locks.—Locks should be kept well oiled, not only the bolt, but the interior, which can be done through the key-hole with a long quill feather. Along with this, dip the key in oil and turn it quickly both ways in the lock. The neglect of oiling is a common cause of locks getting out of order. This is especially the case with locks exposed to the weather, like gate padlocks, rim locks of garden doors, &c. If these are kept well oiled, rain will do them little harm; if not, they will soon rust and go out of order. The best oil for locks is sweet or olive oil.

If notwithstanding oiling, it becomes more difficult to turn the key, it will be well to take off the lock, open it, and give it a good cleaning and oiling. This often adds some years to the life of a lock.

Choice of locks.—Before buying a lock examine the key, and if it be not strong, choose another lock. Sometimes the wards are so cut, that several large ones depend on one slender ward: such a key is sure to break.

The purchaser of a lock must guard himself against being taken in by the complication of the key. Any complication in the key of a cheap lock is pretty sure to be fictitious: most of the key wards are *dummies*, for the lock has just one, or at most two wards, and the key is merely a bait for the unwary.

I shall finish what I have to say about locks, by recommending that good locks be bought. Cheap locks are a waste of money, and indeed something more; for when they go out of order—as they are certain to do—there is trouble and worry, and new ones must be bought. When buying a good lock it is a safe plan to get two keys: while one is in use the other is kept as a reserve in case the first should be lost or broken.

Prices.—The prices of locks are infinitely varied, and it would be impossible, and indeed useless to enumerate all. But I shall give here the prices of a few locks, of various kinds.

Box locks.—A $3\frac{1}{2}$-inch ward and spring iron lock, 9d. A $3\frac{1}{2}$ inch iron tumbler lock of fair quality, 2s. A $3\frac{1}{2}$-inch brass tumbler lock, fair, 2s. 6d.: very good, 4s. 6d. A $2\frac{3}{4}$-inch brass lever lock (6 levers) 4s. 6d.: a 3-inch ditto, 5s. 6d. A good 9-inch stock lock, 4s. 6d. A rim lock (including "furniture," i.e., handles), fair quality, 3s.; good, 5s. 6d.; very superior, 8s. 6d. Mortise locks, including furniture, from 2s. upwards to about 8s. 6d.

There is a small American lock, shaped somewhat like a padlock, extremely simple in construction, and very cheap—$2\frac{1}{2}$d. or 3d.: it answers very well for gates and outer doors, and never goes out of order.

Hinges.

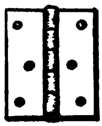


FIG. 43.

Butt Hinges.—Of the many kinds of hinges, the commonest is the butt hinge, Fig 43, which consists of two wings of equal size joined together by being looped at their edges to a wire on which they turn. Butt hinges are distinguished as to size by the length of the wing measured parallel to the wire: thus there are 2-inch hinges, 4 inch hinges, &c. Butt hinges are used for various articles; but a door may be taken as a representative example for all. A door is perhaps the most difficult of all articles to hinge.

To hinge a door.—A door is nearly always hung with two—seldom three—butt hinges, which are so fixed that when the door is shut the hinges are closed in between its edge and the jamb. One wing of the hinge is embedded in the edge of the door, and the other in the jamb; and the rounded edge at the joining of the wings must project so far, that the centre

of the wire will be level, or flush, with the surface of the door and with the surface of the jamb. The width of the wing must be a little less than the thickness of the door; so that the edge of the wing will not show on the outside.

The hinges are to be fixed on the door first. But before going to work make sure that the door is a fit, by trying it in its place. About nine inches from the top, mark on the door-edge the size of the wing (allowing for a slight projection of the round double edge at the wire): and the same about nine inches from the bottom. Sink the bed at each place so that when the wing lies in it, the surface will be exactly flush with the edge of the door.

If by accident the bed is made too deep at that edge of the hinge where the two wings meet, put leather or brown paper under: but it makes no matter if it be a little too deep at the other edge. Screw on the hinges.

Now lift the door into its place, placing the two loose wings against the jamb, where they will have to be screwed, and making sure that the other edge of the door, and the top, fit exactly. Let some other person hold the door in this position while you put marks on the jamb, at the top and bottom of each wing.

This marking is the most critical part of the whole job. The most common error is putting them too low: to prevent this, it may be better to put a wedge under the door, while marking, to keep the top well up against the sill. Having made the marks, remove the door; and with the marks as guides, pencil out the exact size of the wings on the jamb, and sink the two beds as before.

Now, while some one holds the door (open, not shut as before), so that the two unattached wings lie in their beds, mark places for *two* holes in each wing, viz., the top and bottom holes. Having taken down the door, bore the holes; then have it held up again, and drive two screws in each wing

(top wing first)—two only, and not very tightly, because they may have to be withdrawn.

Try now if the door be right—that it shuts and opens freely and fits exactly: if so drive all the screws home and the work is done. But it may be found on first trial that the door is too tight up against the sill—which however should not be the case if the thing had been done with moderate skill. If it be, withdraw the screws and wings from the jamb, and put the holes a shade lower. To do this, first plug the four holes with soft deal, and it will be much better to dip them in glue. Then make the holes at the lower side of the plugs. When at last the door comes right, you have four holes with plugs near them (which are not quite so firm as fresh holes), and you have also two fresh holes (viz., the two in the middle of each wing): the door is then quite firm.

If the hinge beds are sunk too deeply, there is a strain that tends to start the hinges. This is at once known by gently trying to close the door: when it is nearly closed you are met by a sort of spring backwards. In this case do not attempt to close it home: withdraw the screws from the jamb, and put thin wedges of leather, chips, or brown paper under the wings.

It may be found on first trial that the two edges of the door do not fit close to the jambs, or that the door will not shut home, because—let us suppose—the lower part of the edge strikes against the jamb. In this case the bed of the lower hinge is not sunk deep enough in the jamb: withdraw the screws and sink deeper—which can be done without drawing the screws of the upper hinge.

Hinged windows and the doors of cupboards, book cases, and presses, are hung in the manner described above, but on account of being lighter and more manageable they are all much easier to hinge than doors. It is easier still to hinge a box, trunk, desk, or chest. In putting on butt hinges, if for

any reason, it is not convenient to sink a bed for each wing, one bed may be sunk deep enough for both at one side: but a bed for each wing is more usual.

Hinges of various kinds.—Besides butt hinges. the chief kinds in common use are H hinges and T hinges. In the H hinge the wings are long in a direction parallel to the hinge-wire—much longer than the hinge-wire itself—giving the whole hinge something of the shape of the letter H. It does not seem that these hinges are much better or stronger than butt hinges.

In the T hinge, one wing is like the wing of a butt, and the other is elongated in a direction at right angles to the hinge-wire: the usual form of this hinge is shown in Figure 44. It is according to the length of this last wing that the hinge is designated as to size —a 9-inch hinge, &c. These hinges are used to hang the doors of kitchens, outhouses, &c. The cross wing is screwed to the jamb at the back (not between the jamb and the edge of the door, as with a butt hinge), and the long wing is screwed on the back of the door.

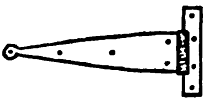


FIG 44.

There is a special box hinge, consisting of an ordinary butt hinge, of which one wing has a long branch wing extending from it at right angles. In putting it on, the butt part is fixed in the usual way, between the edges of the box and cover, and the long branch wing stretches along downwards on the inside of the box to which it is screwed.

To hinge a box (such as that shown at page 100). After what has been said, this will require only a few hints. Suppose butt hinges to be used. They may be placed 4 or 5 inches from the corners; and they are to be inserted between the edges of the box and lid. The wings may be fully as broad as the box edge. A bed is to be sunk for each wing so deep as

to allow the edges to close tight, but no deeper. As in the case of the door, half the round edge containing the wire must project on the outside of the box, to allow the free play of the hinge.

Screw home the hinges by only two screws in each wing at first. If, then, on trial, the edges of box and lid are not quite close, the beds must be deepened. On the other hand if, on trial, the cover does not shut down quite freely, but holds back with a kind of spring, the beds are too deep. Do not force the lid to shut; but unscrew the hinges from the box (leaving them attached to the lid), and insert leather or brown paper under, till the proper depth is attained. Then screw home.

Broken Hinges.—If an old hinge gets broken, it must be taken off and a new one of the same size put on. The manner of removing an old hinge has been already described (p. 66). If the old hinge has to be forced off, the flaws and fractures should be filled up with hard putty, and the new hinge must be fastened on with screws long enough to take a good hold. If the breakage be very bad, a new piece of wood may have to be put in, fastened with glue and screws.

Kinds and Prices.—Hinges are made of both iron and brass; and there are wrought iron and cast iron hinges. Wrought iron hinges are in all respects better than those of cast iron, which are liable to break. Doors should always be hung with wrought iron hinges. Three-inch or $3\frac{1}{2}$-inch hinges—strong make—are the proper size for a door.

The prices of hinges vary according to size, material, and strength. I will give the prices of a few sizes from which one may form some judgment of the prices of other sizes: the prices given are per pair. Three-inch butt hinges (fit for doors which are not very heavy), wrought iron, 9d.; cast iron, 6d. Two-inch butts (for hinged windows, boxes, &c.), wrought iron, 6d. cast iron, 3d.

Whether iron hinges are a little heavier or a little lighter does not make much difference in the price, so long as they are of the same size; moreover, iron hinges of the same size do not in general vary much in strength. But it is different with brass hinges: here there are several degrees of strength for each size, the heavy ones being dearer than the light ones.

Three-inch brass butt hinges, strong, will cost 1s. 9d.; same size, moderately strong, 1s. 6d.; same size, very light, 10d.—but these last are fit for light articles only, and will not bear much strain. Two-inch brass butts, strong, quite strong enough for the size, 9d.; same size, light, 5d.

T hinges (as well as H hinges) are always made of wrought iron: 9-inch, 9d.

Bolts.

To put on a bolt is a very simple matter. The bolt proper is first screwed on to the door in the right place—*screwed, not nailed.* Then the staple is screwed on to the jamb, and of course it must be so placed that the bolt will shoot through it.

After a bolt has been in use for some time, it is not unusual to find that it will no longer shoot through the staple. This arises from the falling of the door by its own weight; and the way to remedy it is to take off the staple and screw it on a little lower.

Iron bolts, 4 inches long, are sold for 4d.; and the price may be calculated a penny an inch up to 12 inches. A 14-inch bolt costs 1s. 4d.; 16-inch, 1s. 6d.

CHAPTER VIII.

CLOTHES RACKS, SHELVES, AND PALINGS.

Driving Nails in Walls.—Sometimes nails have to be driven into the plaster of walls, and no farther; as, for instance, brass-headed nails for pictures or maps, or common nails to fasten up light racks. If the plaster be not moderately good, the nails will have no firm hold.

The nails must not be driven so far as to go quite through the plaster; for if they come against the stones, they will bend and break the plaster; and of course there will then be no hold.

If the plaster be good and hard, a nail cannot be driven into it without first making a hole. Get an awl, not quite so thick as the nail, and, holding it in the left hand with its point to the wall, keep hammering the head of the haft gently, turning the awl round a little in the hole after each stroke. In this way it will work its way gradually. Do not attempt to expedite the work by hammering heavily, which would likely break the awl. The hole should be made nearly or altogether the full depth of the nail, otherwise the nail may bend and will have to be withdrawn, which will likely break the plaster.

Rails.—If the plaster be good, the nails will have sufficient hold to fasten up a light clothes or hat-rack, provided it will not have to bear much strain.

If the wall be brick, the nail may be long, and may be driven deeper than the plaster; for a nail will pierce a brick. The nails for fastening rails may be either wrought or cut. But in all cases it is better to make a hole nearly the full depth: the nail will have the better hold for it. If a hole cannot be made deep enough, and the nail has consequently to make its

own way for some distance, either through plaster or brick, the point should be sharp, but not fine nor weak. If it be a wrought nail, file off the long fine point, leaving it still sharp: if it be a cut nail, file the blunt top till it is a thick sharp point or edge.

Suppose a large rail intended to bear a heavy weight has to be fastened up to a plastered stone wall. Here the plaster will not give sufficient hold, and you have to use brads or wall-hooks (also called holdfasts), from 4 to 6 inches or more in length. The brads or holdfasts are driven in one or the other of two ways: either through the plaster between the stones, or through wooden plugs previously driven in. Plugging the wall is by far the better and firmer of the two plans. In either case you have to find out the spaces between the stones with as little injury to the plaster as possible.

To find the place for a long nail or plug.—First mark out on the wall with a pencil the place of the rail: within the two boundary lines so drawn all the trials must be made. The brad or nail about to be driven should never be used to try, for whenever it comes against a stone, the point will bend, and then there is trouble and damage to the plaster.

The best trier is the sharp shank of an old file: drive the shank through the plaster, hammering gently. When it is in the wrong place it is stopped at once against a stone: when it chances between two stones, it will go any distance. When it has gone deep enough, withdraw it, mark the spot by drawing a vertical line through it a little above and below the two straight boundary lines. Find out and mark in this way as many places as are necessary, where plugs or nails can be driven.

Holding the rail in its place, draw marks across it, corresponding with the marks already made in the wall. Bore holes at these lines, so that, when the rail is in position, brads driven through will exactly catch the holes already made in the wall.

If the wall is not to be plugged, there is now nothing more to do but to hold the rail in its place, and drive the brads. Do not drive them too tightly home, or the elasticity of the rail may loosen their hold. Rails fastened up in this way, however, are liable to get loose under heavy strain. If it is necessary to have the rail immovably firm, the wall must be plugged.

To plug a wall.—Find as before the several spots at the openings between the stones. At each place, knock a hole in the plaster, about three inches across by one inch high: taking care not to injure the plaster beyond the lines. With a cold chisel (p. 12), or any pointed piece of iron or steel, pick out the plaster between the stones, as deep as you can go—three inches or more. Make a blunt wedge of deal, a little thicker than the opening between the stones, and slightly thicker at one end than the other. Place it at the fire till it is perfectly dry through and through—almost scorched—and drive it with a heavy hammer as far it will go between the stones. When it will go no farther, cut the projecting part off with a saw to the level of the plaster. One plug for every two or three feet will be enough.

Put in as many plugs as are necessary, and with long brads nail the rail to them. A rail put up in this way will bear any strain and will never loosen.

To put up a clothes-rack.—Choose a rail of the required length, free from knots, and of the proper scantling: four inches broad and one inch thick is a good size. Keep the best side out. Plane it smoothly; and put a bead moulding along the two edges, or bevel them about half way through the thickness. (p. 94): a bevel looks quite as well as a bead. Paint it: or what is much neater and better, stain it a dark mahogany colour (see p. 128).

Five feet and a half from the floor is a fair height. Mark the place and fasten the rail in one of the ways described above.

The hooks are next to be fixed on at intervals of eight or nine inches. Double hooks, which have two points each, are better than single hooks, which have only one. Hooks are made of cast iron, wrought or malleable iron, brass, and bronze. Those of cast iron are the cheapest and the worst, for they are liable to break. Cast iron hooks of a fair size, with double points can be got for 2s. a dozen: good sized malleable iron hooks, double points, 4s. a dozen. Brass hooks, fair size, and neatly finished, double points, 10s. a dozen : good size plain, double points, 7s. a dozen. Bronze hooks are about the same prices as brass ones. Hooks of all the different materials increase in price according to size and finish.

Fasten the hooks with screws, never with nails : you get screws with the hooks without any additional charge. Take care that the screws are not too long for the thickness of the rail, and that they are not too thick for the holes of the hooks.

A cap and clothes rack for a school is put up in just the same way. Here there will be several rails —say six: the highest $5\frac{1}{2}$ feet from the floor, and the lowest 2 feet. The hooks must be of wrought iron and must be very strong.

To put up a Shelf.—The exact position, height, length, and breadth will depend on circumstances. As to material, common white deal, inch thick, and as free from knots as possible, will answer very well. It will be best if a single board can be got wide enough; but if not, two boards can be joined with one or two dowels (p. 46). Plane moderately smoothly.

The shelf is to be supported by brackets nailed to the wall. If one end of the shelf abut against a side wall, it may be supported at that end by a small lath nailed to the wall under the end. If a shelf is to be put up in a recess 4 or 5 feet wide, the two ends being against two walls, no bracket will be wanted; the shelf can be supported by little laths nailed to the walls at the two ends.

How to make a bracket and fix it to the wall will be understood from fig. 45. The bracket is first made, with a true right angle, as tested by a square or by any square corner. For a common shelf the scantling of the pieces for the bracket may be 2 inches by 1 inch. For greater firmness the end of the diagonal piece may be sunk a little into the vertical piece: take care that the two ends be cut at the proper angles, so as to fit. The three pieces may be either nailed or screwed together, two good strong nails or screws at each joining.

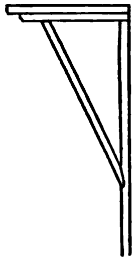


FIG. 45.

Brackets made in this way may not feel very firm as long as they are detached; but once they are fixed in their places with the shelf screwed down on them, they will be quite firm enough.

Having determined the proper places for the brackets, nail them firmly to the wall as described pp. 84-5-6); each should have three or four nails. Be sure that the tops of all the brackets are in range, and that the range is level.

Next, put the shelf in its place, and fasten it with screws (not nails) to the brackets: two screws to each bracket will be enough. The shelf is shown in Fig. 45.

Paling: Palisading: Trellis-work.—There are many varieties of paling, according to the size and

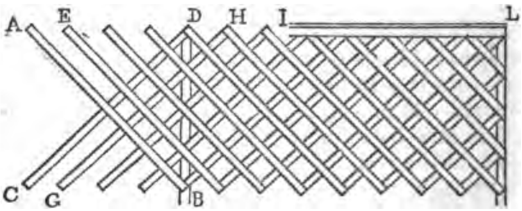


FIG. 46.

the manner of placing the laths. I shall show in de-

tail how to make that form represented in Fig. 46, which is one of the most common, and looks very pretty when well made. Whoever can make this, can make a paling of any shape.

We shall suppose that the laths of this paling are cut in the following way. A deal 10 ft. by 9 in. by 3 inches, is cut into 5 leaves; each leaf is cut across in two; and each of these 5-foot leaves is cut lengthwise into 5 laths: 50 laths altogether from the deal. Each lath, when planed, will be about $1\frac{1}{8}$ inch wide by $\frac{1}{2}$ inch thick. As the laths are 5 feet long, and cross each other at right angles, the paling will be about 3 feet 6 inches high.

It will be observed that each full length lath is crossed by 9 others at right angles, and at equal distances. The places of these intersections must be marked on all the laths in the first instance.

To mark the first lath. Mark off AB $1\frac{1}{8}$ inch (fig. 47), and divide the space BL into 8 equal parts: this

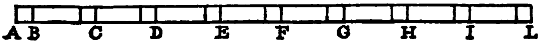


FIG. 47.

can be done by dividing first into two, each of these into two, and each of these last into two; the points so marked will be C, D, E, F, G, H, I, L. To the left of each of these points mark off $1\frac{1}{8}$ inch: there will then be 16 points marked, besides the two ends; through these draw with a square 16 heavy pencil marks across. The lath is then divided.

Using this first lath as a gauge, mark all the others in like manner. Each lath is to be marked only on one side. The marking of the whole 50 will not take more than an hour or so, and it will ensure perfect accuracy in the work.

The laths must be nailed together lying flat on the ground; for which choose some level space, as a wide walk, a plot of close-cut grass, a smooth yard, &c. Use inch cut nails (p. 62); one nail will be enough

for each intersection; and, when driving, have some solid support underneath, such as a flat stone, which can be shifted to wherever wanted. If the points of any of the nails project, they can be afterwards clinched.

First, place AB and CD (Fig. 46) across each other at right angles (use the square) keeping the marked faces turned up. Place them so that the two middle pencil-marked squares will be one down on the other, and drive a nail. Place E next, as indicated in the figure; and when the proper pencil-marked squares are coincident, drive a nail. Place GH, and drive two nails, in the two places where it intersects the laths AB and E.

Continue in this way, working towards the right, till the paling from A to L is of the length required; and as you go along, test with the square from time to time. If the first few laths, however, have been placed accurately square, all the rest will be so.

After this the two ends will have to be finished off square with a number of short laths: best nail each lath full length first, and then cut off the part not wanted. If the thing be managed rightly there will be little or no waste, for the short pieces cut off will come in elsewhere. In like manner finish off the left-hand end.

We shall suppose that the paling is now lying on the ground, complete; and that it will be placed with its lower edge near, but not quite on, the ground.

Supporting posts.—In order to give it support it must be nailed to posts sunk in the ground. The scantling of the posts for this paling may be 3 in. by $1\frac{1}{2}$ in.; and they may be 5 feet long in order to give them a good hold in the ground. They should be shaped at top by chamfering off the corners not in contact with the laths.

There ought to be a post for about every 8 squares, which will place them about 6 ft. 8 in. apart. Dig holes at this distance. The posts must be so placed

as to catch the intersections of the laths. In order to make sure of this, fasten them in the ground only temporarily till the paling is fixed in its place—except the first one, which may at once be fixed permanently. Fix them so that the narrow side of each will be against the paling, as they are strongest this way (p. 3).

When the posts are all standing in position, lift the paling to its place, and support it by driving three or four nails along its length to fasten it temporarily to the posts. When you judge that it is right in position, fasten it home to the first post. Next adjust the second post, and nail up: and go on from post to post to the last. Two or 2½ inch cut nails should be used to fasten up permanently—five to each post.

The manner of fixing the posts in the ground will be understood from Fig. 48. When the post is in its proper place, first ram the clay hard round it with a heavy log of wood having a flat end. Drive a strong pointed stake AB—about 15 inces long—into the ground with a heavy hammer, or with a heavy stick, and nail the cross piece CD—about 15 in. long with several heavy cut nails.

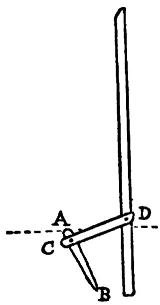


Fig. 48.

Gas tar.—The stake, the piece CD, and the lower end of the post should be painted over with gas tar, and left three or four days to dry before being used. The tar should be put on the post as high as 3 or 4 inches over the ground: for the part most liable to rot is that near the surface. Whenever timber is to stand partly in the ground it should be tarred in the manner here described

It is best to apply the gas tar while boiling, as it then sinks better into the pores of the wood, and preserves it longer; but it must be boiled in the open air, as it is liable to take fire, and might be dangerous

in a kitchen. It will be improved by melting 1 lb. of pitch in every gallon of tar. Any old tin can will do to boil it in, for it will spoil a good pot. It can be applied with any coarse brush. If the hands get daubed, they may be cleaned by scrubbing them in any kind of grease, and afterwards washing them with hot water and soap.

If there be no gas tar, a paint formed of drying oil (see Index) and common coal ground into fine powder may be used instead. In the absence of both, the ground ends of the timber may be charred, which is done by placing them on the top of a clear fire till they are burnt black on the surface. But of course this weakens the timber. Gas tar costs 6d. a gallon.

The paling represented at page 88 may be left raw at top, as is shown in the part from D to I; or it may be finished off as in the part from I to L. To finish off: cut off the top angles, and nail single laths lying flat all along. Or a better way: let the top angles stand; nail two laths along on the two sides, so that the upper edges will be just flush with the angles; and then nail a single lath (bevelled) down flat so as to cover all three—the first two laths and the series of angles. This last finish is shown in the figure. It is to be observed that if the paling be very long, it must be made in parts, and the parts afterwards lifted separately and joined on the posts.

A paling of this kind will be strengthened if a horizonzal lath be nailed at the back from post to post, so as to catch the angles of the several squares.

If a paling is intended as a screen to shut out the view, it is made very close: for this purpose the laths may be an inch broad and an inch asunder. And for still closer trellis work, they may be smaller and closer—say $\frac{5}{8}$ inch. When trellis work of this last kind is well made it looks extremely pretty.

In all cases the laths should cross each other at right angles; you sometimes see them crossing at oblique angles, but the paling never looks so well.

There is no need to be very particular about the planing of the laths: they may be made moderately smooth, and one plane will do the work. A paling should be painted green, and it should get a coat or two every two years at least.

Now as to cost. Suppose the paling to be 20 feet long: a little calculation will show that the 50 laths cut from one deal (as supposed at p. 89), will exactly do it. But if it be finished at top, a few more laths will be wanted.

You may buy the material in the timber yard in any one of three ways: first, the five leaves, cutting out and planing the laths yourself; second, the laths ready cut, but not planed; thirdly, the laths ready cut and planed.

If you buy the leaves without any further preparation, they will cost 3s. (see p. 4); four posts of the size stated, ready cut to size, will cost 1s. 3d. Add 2s. for nails and paint, and the whole cost will be 6s. 3d.

If you wish to avoid the trouble of cutting out the laths, and buy them ready cut (but not planed) they will cost 4s (instead of 3s. uncut), bringing up the total cost to 7s. 3d. But if you buy the laths cut and planed, they will cost 6s. 6d., and in this case the whole paling will cost 9s. 9d.

If you cut the laths yourself, they must first be marked out with the chalk line (p. 94); and, as the leaves are so thin, there will be little labour in running the saw along. Here the saw-cuts must run *on* the lines—not to the right of them (see p. 42). The planing will take considerable time.

In buying leaves for palings, be very careful to choose good clean white deal, with very few knots. For every knot will break up at least one lath, possibly two.

CHAPTER IX.

CARPENTRY WORK OF VARIOUS KINDS.

Chalk Line.—It is often necessary to mark a perfectly straight line, or several parallel lines, along the length of a board, as a guide for one or more saw cuts. This is best done by a chalk line.

Rub chalk on a thin piece of soft cord till it is well covered. Fix the cord tightly at the two ends along the proposed line, which is best done by looping one end over an awl driven into the board at one end, and holding the other end down on the board with the left hand, drawing tightly. Then take the cord between the forefinger and thumb of the right hand, at a point 12 or 18 inches from the left hand; lift it up quite perpendicularly from the board, and let it go. It will slap down and leave a straight chalk mark on the board the whole length between the two fixed points. If the line be not raised quite straight up, it will leave a crooked mark.

Sometimes, instead of chalk, carpenters use the loose charcoal left after burnt straw. This is wetted with water, and the cord is dipped into it. This leaves a better mark than chalk, but it soils the hands.

Bevelling or Chamfering.—To bevel or chamfer is to cut a right angled edge obliquely: fig. 50 represents a bevelled block. The bevel may be equally inclined to both of the adjacent surfaces, in which case

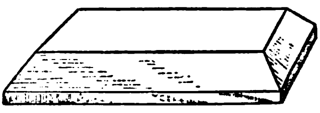


FIG. 50.

it forms an angle of 45° with each; or it may be

inclined unequally. There is a special plane for bevelling; but the thing can be done quite well with any common plane.

Suppose the edge of a board one inch thick is to be bevelled half way through the thickness (like the clothes-rack, p. 86), and at an equal inclination to the two faces. Draw along the middle of the edge a straight line; and another on the face of the board half an inch from the angle, using a straight edge or a gauge. Plane off the angle as far as these two lines. When the plane is approaching the lines the work should be done cautiously, and the plane must have very little iron, lest too much should be planed off.

A bevel is most commonly inclined equally to the two faces. But a bevel unequally inclined may also be made, and in much the same way. Draw a straight pencil line along the edge at any depth desired, say $\frac{3}{8}$ inch; then draw another along the face at the required distance from the angle, say $\frac{3}{4}$ inch. Plane out the angle down to those two lines as before.

Planing up square: or "squaring up," or "truing up."—A piece is said to be squared up when all the sides are straight, level, and square to each other. This is one of the first things an amateur will have to master: and until he does so he cannot do good work.

Suppose we want a piece squared up, 3 feet long, $4\frac{1}{2}$ inches wide, and $2\frac{1}{2}$ inches thick. If there is a piece—or if a piece can be bought—$2\frac{1}{2}$ inches thick, cut it to the required length and breadth, having previously marked it with guiding lines. Run the cuts well outside the marking lines, so as to leave room for planing: at the first rough cutting, better have it an inch or so too long. If $2\frac{1}{2}$-inch scantling cannot be got, then the piece must be cut from a piece of an ordinary 3-inch deal. Cut it just the proper length and breadth, after which saw *nearly* $\frac{1}{2}$ inch off the thickness.

Plane first one of the flat sides level and straight—using a jack-plane. Test the level carefully (p. 37): test the straightness by the eye, or by laying a straight edge along. If it is necessary to use the smoothing-plane, it must have as little iron as possible, or it may disturb the level.

Next plane up one of the two edges in like manner. Here there is an additional requirement: for along with being level and straight, it is to be square with the first side. This last is ascertained by the square: then square up the other edge. Take care that the piece is equally wide at the two ends—testing with the compass.

Plane the remaining side level and straight. It must be square with the two edges. Test also with the compass if the piece be the same thickness at both edges.

Now mark the two ends all round very carefully with the square and a well-pointed pencil, and cut them with a tenon-saw. This should leave the ends quite square; but if it does not, they must be pared with a very sharp chisel: the plane can hardly be used on account of the shortness of the surface.

Warping.—Thin pieces of board are very apt to warp *across the grain:* and hard woods are often found more liable to this than deal. If a board has warped, wet it well on the concave side till the water soaks into it, and hold the convex side before a fire: this will likely bring it to its level, because wet expands timber, and drying contracts it. If this does not succeed, lay the board down flat, convex side up, and put heavy weights on it: in a day or two it will be quite flat.

But there is danger that the piece will warp again. Suppose you want a piece of wood 12 inches square, and 1½ inch thick, and that it is of great consequence to keep it from warping. Get two pieces, each of the size required, and ¾ inch thick—truly squared up—and screw them together tightly, so that the grain

of one will lie across the grain of the other. With this size of board, five screws will be enough, four in the corners, about one inch from the edges, and one in the centre. Of course the screws must be a little shorter than 1½-inch; and the heads must be neatly countersunk. This compound board will never warp. A drawing-board, which must be perfectly level, may be made in this way.

A piece of board may be kept from warping by screwing strong laths or ledges across the grain, at least three screws in each, one screw near each end, and one in the middle. This method applies when one side of the piece is hidden from view. It may be also applied in making a drawing-board, whether consisting of a single leaf, or of two joined edge to edge, and held together by the cross ledges.

Splitting wood.—Wood will split with the grain if there is nothing to force the split from its natural track. Suppose the grain of a piece of wood runs all along parallel with the sides: then if you split in the middle, the split will go straight from end to end. But if you attempt to split a small piece off the side, the bending of this piece will force the split nearer and nearer to the side, and the piece split off will grow narrower as you approach the other end. If you want, therefore, to get from a board a slit of uniform width, it should never be taken off by splitting. Even if you wish to divide a board into two equal parts lengthwise, it should not be split, for you are never sure of the grain. In all such cases the saw should be used.

Suppose you are about to split up logs with a hatchet into small pieces for firewood, &c.: this is the best and easiest way. Split the log first in the middle; split each of these two equal pieces exactly in the middle in like manner: and so on. If in any case you attempt to split into unequal parts, the split will run out towards the side, and the log will give trouble.

To make a mitre-box.—(Read the short description at p. 49, and examine Fig. 51). Get a piece of deal board about 24 inches long, 9 inches broad, and 1 or $1\frac{1}{2}$ inch thick: and 2 other pieces the same length, $2\frac{1}{2}$ inches wide, and 2 inches thick. It will be better to have these two of some hard wood: but good white deal will do very well.

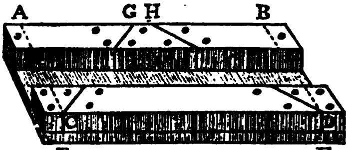


FIG. 51.

Plane and square all three very accurately (p. 95). Screw the two pieces firmly on the board, as in the figure; but in the first instance, make holes for, and drive only two screws in each, viz., at the two ends. Be very careful that the two pieces are exactly parallel.

Mark two points A and B, two inches from the ends; and with the square draw two fine pencil lines AC and BD. Draw with the square two lines CE and DF, down the sides; and two others from A and B down the far side. Measure off *very accurately* the two distances AG and BH, both equal to the width AC or BD; and mark the points G and H.

Draw with a ruler the lines CG and DH: these two lines will make half a right angle (45°) with the sides. Now make holes and drive the rest of the screws. With a tenon-saw make a cut along the line CG through the two pieces down to the board; and do the same along the line DH.

This last is the most difficult of all to do rightly; for the cuts must go down exactly square with the two pieces, i.e., along the line CE and DF, and along the corresponding lines from A and B at the far side. If the amateur fears that he cannot cut square, it may be better to arrange a guide for the saw; for this mitre-block is to stand for all future time. To

make a guide, get two bits of board 10 in. by 3 in. by 1¼ inch thick, and by means of plane and square make one long edge on each perfectly straight and square with one flat side (p 95). Screw these down temporarily, with the squared edges along the line CG, one on each side, so as barely to have room for the saw. This will serve as a guide till the cut is deep enough to guide itself, when the two pieces can be taken off and the cut completed. The other cut is made in the same way.

When screwing down the two main pieces in the first instance, care must be taken that each of the small pieces between the cuts have at least 3 screws to hold it firm, after the cuts are made. This is shown in the figure.

The mitre-block is now finished, and any piece up to 4 inches wide can be mitre-cut with it (see p. 49).

To make a Shooting Block.—(Read the short description at p. 50, and look at Fig. 52). Get two pieces of board, one about 24 inches long by 11 inches broad, by 1 or 1½ inch thick;

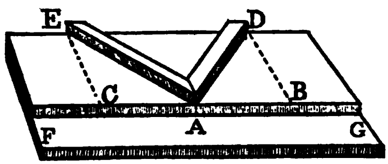


FIG. 52.

the other 24 inches by 7 inches by 1 inch. Square them up accurately, and screw the narrow one down on the wide one, as in the figure.

Down on the small board are to be placed two slits, forming half a right angle with the edges of the boards (and consequently forming a right angle with each other). These may be 10 inches long, 2 inches wide, and 1 inch thick, very accurately squared up. To mark out their positions: take A the middle point of the edge of the narrow board. Mark off exactly the breadth of the same board (7 inches in the present case) from A to B and from A to C. Draw with the

square the lines BD and CE. Mark the points D and E accurately, and draw with a rule two fine pencil lines, AD and AE. These two lines will make half right angles with the edges of the boards. Now cut the ends of the two slits so as to fit as shown in the figure, and screw them down with their edges exactly along the two pencil lines.

This is the shooting board. The manner of using it is described at page 50.

To make a Nail Box.—This is one of the very first things an amateur should make for his own use, to hold nails, screws, hooks, awl blades, &c. Fig 53 represents such a box; it may be about 15 inches long, 12 broad, and 4 deep; and the stuff may be ⅝-inch thick.

FIG. 53.

Square out and nail up the four sides first: it will be unnecessary to dovetail; simple nailing with 1¼ inch cut nails will answer quite well. Next nail on the bottom, after which fit and nail in the long middle partition containing the loop for the hand. Lastly, the little cross partitions are fitted and nailed in. The box may be either stained or painted (pages 119 and 128.)

To make a Box.—If the box is to be pretty large and strong, the boards should be inch thick; but for a small box ¾-inch will do. First make the four sides to the proper size; the timber for these must be thoroughly well seasoned. Having accurately planed and squared up the separate boards (page 95)—which may be 9-inch—glue them edge to edge; they will not need dowelling. If they be rabbeted, they should not be bead

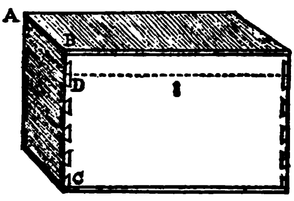


FIG. 54.

moulded; for the object here is to conceal the joinings. Observe, these four sides are to be made the full depth from B to C, Fig. 54.

Having made and squared up the four sides, they are to be dovetailed at the four angles (p. 60), as shown in the figure. Next make the top and bottom to the proper size. It will be better to rabbet the boards that form these (p. 40), to provide against the contingency of wet: they will of course be glued. The top and bottom of the box may be simply nailed on to the sides, but the joints should be close, and glue should be used.

There is now a hollow box made, altogether enclosed. Mark the depth of the lid BD—say 2½ inches—and draw a pencil line exactly at this depth all round the four sides—represented, so far as it can be seen, by the dotted line.

Run a cut with a saw along the dotted line all round the four sides: this will cut off the lid. This cutting off of the lid calls for more skill than almost any other part of the work, for the saw must be worked with great accuracy. It will be better to begin at a corner; but a beginning may be made anywhere by making a small gimlet hole and starting the cut with a lock or pad saw. The amateur will find the latter the easier plan.

After cutting off the lid, plane up the cut edges, using a jack plane *with very little iron:* the less planed off the edges the better, for once the exact fit is lost, it is not easy to restore it.

In cutting the dovetails in the first instance, make the one at D of double length, and so placed that the cut will pass through the middle of it.

By making the entire box first, and afterwards cutting off the lid, as here described, the lid is sure to be an exact fit. But the lid may be made separately and planed to an exact fit afterwards—if it is not an exact fit already. This latter plan is more troublesome than the other.

For the way to put on lock and hinges see Chapter vii. This box may be either painted or stained any required colour.

Cost.—Suppose a box 2 ft. 9 in. long by 1 ft. 8 in. wide by 1 ft 7 in. deep: made of good white deal inch thick. Timber about, 3s.; lock, 2s. (p. 78): hinges, 9d. (p. 82): nails and paint, 6d.: altogether, 6s. 3d.

To make a Writing Desk.—A writing desk is usually of the shape represented in Fig. 55, hingeing at the middle of the back, so that when it is opened out, the two inside covers of the two parts form one flat surface slightly oblique for writing on.

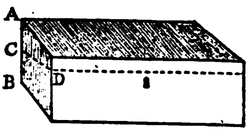


FIG. 55.

A good size for a desk—when closed—is 18 inches long, 12 in. wide, and 7 inches deep: but desks are often made much larger. Make a box this size, as already described. To mark for the lid. Take the point C exactly in the middle of the line AB: and take the point D about 2 inches from the top edge. Draw the oblique pencil line CD. Through D draw a line along the front side parallel with the edges: through C draw another parallel line along the opposite side: and along the right hand end draw another oblique line to correspond with CD.

Now run a cut all round, as already described: on account of the obliquity it is somewhat harder to run this cut than in the plain box. (But, as in case of the box, the cover may be made separately). Plane up the newly cut edges till they fit: after which put a pair of very light brass hinges at the back, and a small lock in front. In a desk lock, the top plate BB (Fig. 41) makes, not a right angle, as in the box lock, but either an obtuse or an acute angle with the main plate, to match the inclination.

Each of the two parts must have an inside lid; so placed, that when the desk is opened out, these two

inside lids form one continued surface for writing on. They should be very thin, and should be covered with velvet or American cloth, which may be put on so that it will serve for hinges. The interior may be divided into compartments to hold note paper, envelopes, &c., in any way to suit the amateur's taste.

A desk should be made of one of the better class of woods. If mahogany or walnut is not available, yellow pine may be used; and if it is carefully smoothed and stained (p. 128) it will look almost as well as mahogany. The whole of the 12 edges, instead of being quite square and sharp, may be slightly rounded.

To make a Ledge Door (for a kitchen or an out-house). We shall suppose the jambs and sill are already in their places; and that nothing but the door has to be made. Let the opening of the jambs be 6 ft. 6 in. high, and 2 ft. 6 in. wide. Some doors of this kind are made to fit accurately into this opening; others shut against the jambs: our instructions will reach both plans.

We shall suppose the door to be 1 inch thick, and that it has 3 ledges at the back, 1 inch thick and 6 inches wide. The boards may be either 9-inch or 7-inch; we shall take 7-inch. Fig. 56 shows how each board is to be rabbeted and moulded; or the bead moulds may be placed as in Fig. 58, p. 106. Of course the two boards at the two edges of the door must have their outer edges squared. The two extreme ledges may be within 4 or 5 inches of the top and bottom, and the middle ledge may be in the middle of the door. Nail on the ledges with $2\frac{1}{2}$-inch wrought nails (bradded: p. 63): drive them in at the front and clinch them at the back. Fig. 57 is the door.

FIG. 56.

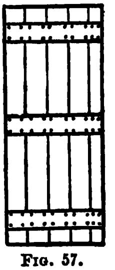


FIG. 57.

This door should be hung with two strong T hinges

(p. 81), which go on the top and bottom ledges. The lock—if there be one—is put on the middle ledge. It is usual to put a common thumb latch on a door like this. I shall not describe how to put it on, but recommend the amateur to examine any door with a latch, which he will find no difficulty in imitating.

The timber for this door, supposing the amateur himself to plane, rabbet, and mould it, will cost about 2s.; or, if bought ready planed, rabbeted, and moulded, about 3s. Hinges, 9d.; nails, 2d.; latch, 9d.; total, 3s. 8d. or 4s. 8d. N.B.—Thumb latches vary in price from 6d. to about 1s. 9d., according to size and quality.

To mend the bottom of a Door.—Sometimes the bottom of an outer door that is much exposed to the weather rots and becomes jagged and ugly looking.

This may be mended in a very simple way. Get a piece of board, inch or ¾ inch thick, as long as the width of the door, and so broad that when laid against it across at the bottom, it will cover the broken part. Square it up, and bevel half through the thickness (p. 94) the edge that is to lie along at the top. Screw or nail this on the door in the proper position. It should of course get a couple of coats of paint.

Sheeting.—Sometimes a room, instead of being ceiled, is covered with a sheeting of thin deal boards. If there be a room overhead, the matter is easy enough, for the sheeting boards can be nailed up to the joists.

If a roof which is immediately overhead is to be sheeted, the boards must run in the direction from side wall to side wall, i.e., in the same direction as the rafters and collar beams. If it be a slated, thatched, or tiled roof, the rafters run up and down, and it will be necessary to nail across them, and across the collar beams, a number of pieces to catch the sheeting. The scantling of these pieces may be 2¼ inches by 1½ inch (so that 8 may be cut from a 3-inch

deal: see p. 4); and they must be nailed to the rafters, not flat, but on the edges, as they are stronger and less liable to bend in this direction (p. 4). The nails should be about 2 inches longer than the depth of the cross pieces; i.e., say four inch nails for the present scantling. One nail will be quite enough at each crossing. If the sheeting is to be $\frac{1}{2}$ inch thick, the cross pieces may be placed at intervals of 2 feet; if $\frac{3}{4}$ inch, at intervals of 3 feet.

In nailing up these cross pieces, great care must be taken that they are all in range. Better nail up the top and bottom pieces first: see that they are truly level, either by a spirit level or by measuring the height of each end from the floor. To test if these two are in range: stretch a piece of cord from the left hand end of the upper piece to the right hand end of the lower, and nail it at both ends so that it will be tight. Nail the end of another cord to the right hand end of the top piece, and stretch it across the other to the left hand end of the lower. Try first the second cord *over* the first, then *under* it. If the two cords exactly touch in both trials, the range is true. If they do not, the pieces are not in range. Suppose when both cords are tight, one runs under the other $1\frac{1}{2}$ inch. Then either the upper or the lower piece must be raised at one end from the rafter *double* this space; i.e., 3 inches. This will put the pieces in true range. The intermediate pieces are then put up, the range being always tested by a long straight edge. If the rafters themselves do not range, it will be necessary sometimes to cut notches in the cross pieces, and sometimes to insert wedges between them and the rafters. In this way all are brought into range with the top and bottom pieces.

If the cross pieces are not long enough to reach the whole way, and have to be joined, the joint should be in the middle of a rafter; and of course the end of each piece should have a nail.

If the roof be covered outside with corrugated or

fluted iron, the supports on which the iron rests run across instead of up and down like rafters. To these cross pieces the sheeting may be nailed without further preparation; for they must be always truly ranged, to catch the iron outside.

It is better to sheet with 7-inch leaves, which are less liable to warp than 9-inch. The leaves may be $\frac{1}{2}$, $\frac{5}{8}$, or $\frac{3}{4}$ inch thick. They should be rabbeted at both edges on alternate sides, and bead-moulded at one edge. This rabbeting and moulding—as well as the planing—may be done by the amateur himself; or the leaves may be bought ready planed, rabbeted, and moulded. The manner of rabbeting and moulding, and of joining them, is shown in Fig. 58; or the rabbets and mouldings may be made as in Fig. 56. Two-inch cut nails are best for fastening them up (or $1\frac{1}{2}$ inch if the sheeting be $\frac{1}{2}$ inch). Two nails will be enough for each leaf at each crossing, one near each edge.

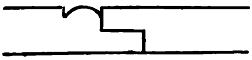


FIG. 58.

The ends of the boards must be cut and planed quite smooth and square, so that where the ends meet in the angle between rafters and collar beams, the joining may be perfectly close.

The sheeting may be either painted or stained; but staining is better. A light oak stain will look extremely well (pp. 128, 131).

Sometimes a wall of an apartment is sheeted: when, for instance, the wall is incurably damp. Here it will be necessary to nail horizontal cross pieces very firmly to the wall to catch the sheeting (see p. 85), care being taken that they range, as in case of roof sheeting.

When a wall is sheeted, it will be better—if it can be done—to fill up with some sort of dry stuffing the space between the sheeting and the wall; for otherwise it is sure to be the home of insects of various kinds. Perhaps the very best filling stuff is dry bog or peat dust, which is plentiful enough in many parts

of Ireland. Saw-dust, which can be bought at the timber yards, may also be used.

If it is intended to stain or paint this wall sheeting, the leaves are to be rabbeted and moulded as for roof sheeting. But if the sheeting is to be papered, the leaves are to be rabbeted only—not moulded. For the manner of papering boarding, see Chap. xiii.

In all cases of sheeting, if the work is intended to be very neat looking, the nails should be sunk with a punch, and the holes over the heads filled up with putty.

Cost.—Suppose a room 18 by 14 feet has overhead a roof with collar beams—the 18 feet forming the width of the house. Here there are three flat spaces to be covered, one horizontal up against the collar beams, and one oblique on each side, forming portions of the slanting roof. The length of all three is the same, namely, 14 feet: let the width of the flat space at top be $8\frac{1}{2}$ feet, and the width of each of the other two, 6 feet.

Take first the cross pieces: for simplicity we shall suppose that they can be got the full length—14 feet. It would be easy, by a little management, to make one cross piece serve in the angle between rafters and collar beams, so that the ends of the adjacent boards meet in the middle of it: but it is better to have two, up against each other. Counting two at each angle, and supposing the others to be about two feet asunder, it will take 13 pieces. Following the rates set down at page 4, these 13 will cost, ready cut (but not planed), about 6s. 7d.

For the sheeting, we shall suppose that 5 leaves are cut from a batten 3 inches thick. It will take 26 of these leaves of $8\frac{1}{2}$ feet long (which will count as 9 feet in buying) to cover the horizontal part at the collar beams; and 52 of 6 feet long to cover the two slanting parts of the roof. In this calculation the leaves are taken as $6\frac{1}{2}$ inches wide, half an inch being lost by rabbeting. Still following the rates given at

pp. 4-5, these 78 leaves, if bought unplaned, will cost £1 5s. 9d: if bought planed, but not rabbeted or bead moulded, £1 11s.: and if bought ready planed, rabbeted, and moulded, £1 16s. 4d. Allowing 2s. 6d. for nails, and 7s. 6d. for staining and varnishing, the total expense of the materials will be:—

If leaves are bought rough, £2 2s. 4d.
If leaves are bought planed, £2 7s. 7d.
If leaves are bought planed,
rabbeted, and moulded, £2 12s. 0d.

Flooring.—*To board a ground floor.*—Suppose a room with a clay floor, 18 by 14 feet, is to be boarded. If the room is lofty enough to bear a diminution of 6 inches in the height, it will be by far better not to dig away any of the clay floor, but to place joists and boards over it: provided this can be done without obstructing the movement of the doors. But if the doors will not allow it, the floor must be dug away to a depth of 6 inches or so.

The joists are to run across and the boards lengthwise. As the joists may rest on supports at several points of their length, they may be very light: $4\frac{1}{2}$ in. by $1\frac{1}{2}$ inch will be heavy enough; so that 4 can be cut from a 3-inch deal. They may be about 18 inches asunder; and they should be raised about an inch from the floor. The ends should rest on stones firmly set in mortar, and thin stones should be wedged under in three or four places along each joist: each supporting stone should be sunk a little, and firmly set in the floor to prevent displacement.

The boards may be inch thick, and may be either 7 or 9 inches wide. As one board cannot reach the whole length, there will be a joining, end to end: this joining should be on the middle of a joist. The boards should be well seasoned, and should be forced together as closely as possible. They should be nailed down with 2, or $2\frac{1}{2}$ inch flooring brads—three in each board at each crossing. The heads should be sunk

by a punch: otherwise, when the boards wear away in course of time, the heads will project, and will be dangerous.

Cost.—Twelve joists will be enough, and will cost 12s. 3d. If the boards are 7 inches wide, it will take exactly 28 of 12 feet long, and 28 of 6 feet long; which are equivalent to 42 twelve-foot boards. These, if bought planed, will cost £1 18s. Allowing 2s. for nails, the total cost of the materials will be, £2 12s. 3d.

To make a wooden field gate.—Fig. 59 represents a common gate to keep out cattle; we suppose it to be about $6\frac{1}{2}$ feet wide, and four feet high, so that a cart may pass through when the gate is open.

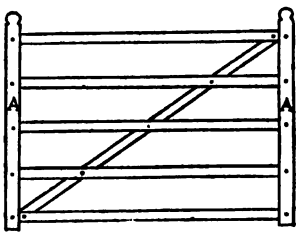


FIG. 59.

The scantling of the two styles AA may be $4\frac{1}{2}$ by 3 inches: the cross pieces or bars may be about 4 inches by 1 inch. These cross pieces must be mortised into the styles: the mortises should be the full size of the cross pieces. The bars should be fastened in the mortises by stout hard-wood pins, or by strong nails.

The diagonal bar (or cross-stay) is necessary to prevent the gate from falling out of shape by its own weight. It must be nailed or pinned firmly to the cross bars, but is not necessary to connect it with the styles. For additional firmness there may be another diagonal bar on the front face joining the other two angles.

A gate is hung either between stone piers or between timber posts. If posts are chosen, they should be very strong—say 9 inches square. They should be sunk at least 2 feet in the ground—having been previously gas-tarred (p. 91)—and a mixture of clay and small stones or broken bricks

should be rammed tightly round them. They might also be secured in the manner shown in Fig. 48 (but in case of the gate-post, the brace-piece CD should catch the post much higher up).

If there are stone piers, it is usual to have two posts also for hinges and catch, which need not be heavy and need not be sunk far in the ground, as they can be fastened securely with holdfasts to the piers.

There is great strain on the hinges of a field gate, so that they should be extra strong, and should be fastened on very firmly: if they be not so, they are sure to be the first part of the gate to give way. The hinge shown in Fig. 60—called the *hook-and-eye* hinge—is the best form of hinge for a field gate: T hinges are hardly ever made strong enough for this purpose, and almost always break. The gate can at any time be lifted off these hinges, which is often a convenience. They must, however, be driven very firmly in the post or be clinched: otherwise they are liable to come out—especially the upper one. These hinges are usually hand-made, and are always of malleable iron: a 12 inch pair will cost about 1s. 6d.

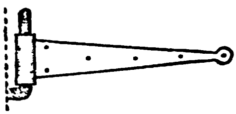


FIG. 60.

It is unnecessary to describe in detail how to put on hinges, latch, hasp, and staple.

Fig. 61 shows another form of gate, intended to keep out the smaller animals—pigs, geese, &c. The upright bars may be $2\frac{1}{4}$ inches by 1 inch, and may be put closer than the figure represents them if necessary. They might also be extended an inch or two below the bottom cross bar.

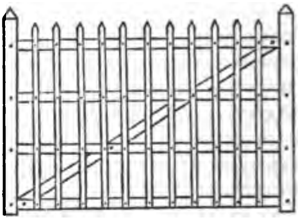


FIG. 61.

When this gate is nicely painted it looks very

pretty. If made on a smaller scale—say three feet square—it will answer very well as a garden gate.

If gates are not kept regularly painted, they will soon rot and go to destruction. They should get a coat every year, of any colour to please the eye. This will not only preserve them, but will give them a neat and ornamental appearance.

To make a carpenter's square.—Get two pieces of fine straight-grained deal: one for the stock, 7 inches long, 2 inches wide, and 1¼ inch thick: the other for the tongue, 11 or 12 inches long, 2½ inches wide, and about ⅜ inch thick. Plane and smooth them with the greatest accuracy: especially see that the edges are straight and parallel. If mahogany, or beech, or other hard timber is available, it is of course better than deal.

At one end of the thick piece make an open mortise (p. 56), 2 inches deep, and ⅜ inch broad, so that the tongue may fit pretty tightly into it: when the tongue is put into this there will be half an inch of it left outside as shown in Fig. 62. The joint is to be secured with two screws: or with four—two from each side. Fix the tongue first at right angles, so far as the eye can judge, and drive one screw.

To test now if the angle be true. Take a board with a perfectly straight edge BC, Fig. 63; or use the straight edge of a table, &c. Put the stock from B to A, and draw a line from A across the board. Now turn the square, putting the stock from C to A, and draw another line from A across the board. If this second line exactly coincides with the first, the angle is truly square, and the second screw may be driven.

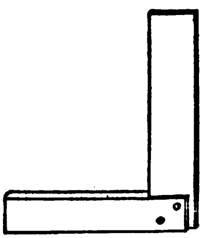


FIG. 62.

If the second line depart from the first, the angle

is not true. Suppose the first line is AD, and the second AG. Let these two lines be drawn of equal length: and with a compass, mark the point F, half way between D and G. Draw the line FA: the angle BAF will be a true right angle. Now adjust the tongue till its edge runs exactly along AF while the stock is along the straight edge: the square will then be true, and the second screw may be driven. Before boring for the second screw, it may be well to make a very small hole and drive a fine sprig temporarily through the joint: this is to prevent the tongue being disturbed from its position by the boring and screwing. This square is quite as good as one that is bought: but of course it will not bear rough usage.

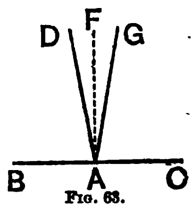


FIG. 63.

To make a carpenter's bench.—Although I have deferred the description of this so long, it is one of the first things an amateur will have to get—that is if he does much carpentry work. If he buys a bench it will cost at least £1 (p. 23). But one larger and equally good in other respects may be made by any handy man for less than half the money.

Very little description will be necessary to render Fig 64 intelligible. This bench is 6 feet long, 2 feet 3 inches wide, and about 2 feet 9 high. The material of which it is made should be all planed; but otherwise it may be put together roughly—no tenon and mortise being necessary.

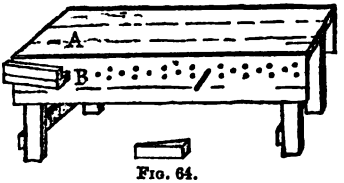


FIG. 64.

The top is formed of three boards, each 9 inches wide, and at least two inches thick. The two side boards may be inch thick and of any con-

venient depth: here they are about 16 inches. The legs should be strong—about $4\frac{1}{2}$ by 3 inch scantling: and they may be secured with strong cross pieces as in the figure—simply nailed against the sides of the legs: two other pieces might be nailed lengthwise if thought necessary. On the top of each pair of legs there is a stout piece, not seen in the figure, running across from side to side on the under side of the top, to which both the legs and top of the bench are nailed; and if it appeared necessary to strengthen the bench still more, there might be diagonal cross pieces.

The stop at A is intended for a board to rest against it when laid flat for planing. It is made in this way. A square hole is cut through the top, say $1\frac{1}{2}$ inch each way: it may be put 6 or 8 inches from the end. A plug is made for this $1\frac{1}{2}$ inch square, and 4 or 5 inches long: it must fit the hole very tightly, so tightly that it will require a light stroke of a hammer to move it up or down. The plug is inserted in the hole so as to rise a little over the surface; and it can be adjusted to suit the thickness of any board. If you want to lower for a thin board, strike it on the top: if you want to raise it for a thick one, strike it underneath.

At B there is often a bench screw for gripping a board, so as to hold it firmly edgewise while the edge is planed. These screws can be bought separately in the tool shops, and can be fitted on any bench. A wooden screw will cost 2s.: an ordinary iron one, 5s. or 6s.: and the instantaneous grip screw—the best of all—16s.

But many who write for amateurs lay far too much stress on bench screws; as a matter of fact, the greater part of all common carpentry work done by tradesmen is done on benches without screws. The wedge arrangement shown in the figure is that commonly adopted, and for ordinary use it will hold a board as firmly and will answer quite as well as a screw. A stout piece of board, about a foot long

projects from the left of the bench about four inches lower than the edge: it passes through the side leaf of the bench, and is nailed or screwed firmly up against the under side of the top. Down on this is screwed or nailed another piece, rising four inches over the first, so that its upper surface is on a level with the top of the bench; and so placed as to leave between it and the side of the bench a wedge-shaped space about 3 inches wide at the left, and about 5 inches wide at the right. There is a wedge to correspond with this opening (shown under the bench), about 1 inch thick at the thin end, and 3 inches at the other. In the nearer side leaf are a number of holes about $\frac{3}{4}$ inch in diameter, and there is a peg of the same diameter, which fits tightly into them. This peg can be put into any one of the holes; and when it is in its place it projects out some inches, as shown in the figure.

To fasten a board edgewise for planing. Put the peg into one of the holes: lay the board on its edge. resting on the peg and on the projecting piece on the left. Insert the wedge outside the board, and tap it gently with the hammer till the board is firmly gripped. A light tap in the opposite direction will loosen the board.

		s.	*d.*
Cost.—Top: 3 boards, 6 ft. × 9 in. × 2 in.,	...	3	0
Four legs, $2\frac{3}{4}$ ft. × $4\frac{1}{2}$ in. × 3 in.,	...	1	6
Four cross pieces, about	...	0	9
Two side boards, 6 ft. × 16 in × 1 in.,	...	1	9
Nails or screws, ...	...	0	6
Total,		7	6

CHAPTER X.

HOUSE PAINTING.

HOUSE painting is one of the simplest and easiest of all handicrafts for an amateur who does not attempt too much. Most of the ordinary painting needed in and about a house may be done by anyone having the use of his hands.

Different forms of paints.—Paints may be bought in three different forms:—first, as powders, or dry paints; secondly, ground up with oil in the form of a thick paste: thirdly, sealed up in tin canisters ready for use.

Oil and Turpentine.—Oil and turpentine (or *turps* as workmen call it) are mixed with paints to make them thin enough for use. The oil used is *boiled linseed oil:* raw or unboiled linseed oil is seldom used, as it takes long to dry.

Driers and Drying Oil.—There are substances called driers, which when mixed with the oil, cause it to dry more quickly. The principal of these are litharge, sugar of lead, sulphate of zinc (or white copperas), and red lead. But an amateur will seldom or never have anything to do with these; for when linseed oil is boiled, it is always boiled with driers. Oil prepared in this way is what is commonly called *boiled oil* or *drying oil*, and it is the oil that should be bought for paints.

Even if paints are bought ready for use, one should have some drying oil and turpentine at hand, as either or both will most likely be wanting to thin paints that have become too thick.

Observe, however, that drying oil is dark and dirty looking in colour, on account of the driers, and would spoil white or delicate paints: for these, raw oil, which is clear, must be used, mixed with sufficient turpentine to cause it to dry soon (see next page).

Flat and Glossy Painting.—Paints, whether dry or as a paste, may be thinned for use with drying oil alone, or with turpentine alone, or with a mixture of both. If oil alone is used, the paint, when dry, will have a shine or gloss. If turpentine alone is used, the paint will dry with a dead surface without the least gloss: this is what is called *flat* or *flatted* paint (for which see p. 122). If the two are mixed to make paint, the greater the proportion of oil the greater will be the gloss; the more the turpentine, the less the gloss. In some cases it is desirable to have a gloss, in others not: and the paint is made up in accordance with what is wanted.

If turpentine alone or nearly all turpentine is used, the paint will dry in an hour or so. If turpentine is mixed with oil paint it will cause it to dry all the more quickly; and the greater the proportion of turpentine, the sooner the paint will dry.

Moreover, turpentine mixed with paint hardens it; and the more the turpentine, the harder the paint will become when dry.

For ordinary work there may be double as much oil as turpentine; or the two may be half and half. Paint thus made will dry in about 24 hours, and will have a moderate gloss.

Drying oil costs 2s. 10d. a gallon; raw linseed oil, 2s. 6d; turpentine, 3s. If driers have to be bought, ask for "driers" or "patent driers," without specifying the kind; the price is 4d. a pound.

Dry Paints.—Dry paints of the various colours can be bought at the oil and colour shops, or at the druggists, and sometimes in a grocery shop or general warehouse in country towns. They are nearly all very cheap, generally from 3d. to 6d. a pound (see p. 125 for prices).

Grinding.—Dry paints must be ground perfectly fine before they are fit for use. Whether they are ground sufficiently or not can be at once known by feeling the powder between the finger and thumb: if

there is the least grittiness the paint must be ground. Formerly most dry paints needed grinding after being bought. But now dry paints are nearly always sufficiently ground as they come from the shop, so that a painter or an amateur very seldom has to grind his own paints.

There is a *muller and slab* for grinding paints: the slab is a flat piece of marble 15 or 18 inches square, on which the paints are ground by the muller. The dry paint is mixed with a little drying oil so as to form a thick paste; in this form it is ground till it feels between the fingers perfectly smooth, like butter. Muller and slab will cost about 2s. 6d. But the paste may be ground, though slowly, on a broad smooth slate with a broad-bladed knife.

To prepare dry paint.—Supposing the dry paint ground fine enough, the following is the way to prepare it. Put as much as is wanting into a paint pot, or any suitable vessel, and add a small quantity of boiled oil (if it be a paint that admits of boiled oil), as much as will make a thick paste. Mix it up with a flat bit of stick till it is perfectly uniform, and then add oil, or turpentine, or both (on this point see farther on), stirring all the while till the paint is thin enough. It is fit for use when it is something like cream.

One pound of dry paint will take about half a pint of oil, or turpentine, or both. If the paint be made too thin, the coating will not remain uniform, but will have a tendency to run off like water; and it will scarcely hide the wood or the old paint underneath. If too thick, it will be difficult to lay on, and will form a rough coating.

Moist Paint.—The second form in which paints are sold is moist—i.e., as a thick paste. In this form you may buy all the various colours; average price, from 4d. to 6d. a pound. They require no preparation but thinning them with oil, or turpentine, or both.

Canister Paints.—But thirdly, paints are now very generally sold in tin canisters of various sizes, containing from 1 lb. upwards, ready for use—nothing to do but cut open the canister. All the colours are sold this way; general price, 6d. for a lb. canister. You know the very colour you are buying, for it is painted on the lid. This is the most convenient way to buy paints. There is a kind of scissors for cutting open the canister like that used for opening meat tins: it is usually kept in the shops with the tins, and costs about 3d. But the canister can be opened with a strong, broad-topped awl, or an old chisel, or a strong old knife. It will be generally necessary to take the top completely off; for the heavy pigment will be often found to have settled down in the bottom, and will require a strong hand to loosen it and stir it up.

Though canister paints are so convenient, they are not so economical as either the dry or the paste paints. Moreover, it is important to remember that canister paints are usually in oil, with a little turpentine. They are in fact oil paints; and whenever *flatted* or turpentine paint (see p. 122) is wanted, the canister paint will not answer.

Paint Brushes.—Paint brushes are of various sizes and prices. The largest is what is called a *pound brush*, used for painting broad surfaces, as doors, gates, &c., and costs from 2s. 6d. to 3s. 4d., according to size. The others, often called *sash brushes*, or *sash tools*, are smaller; and, according to their size, they cost from a few pence up to 2s. A good medium sash brush may be bought for 1s.: this single brush will be enough for most of the work taken in hands by an amateur. But if small work has to be painted—such as the slender parts of window sashes—a small brush or two will be necessary.

A new brush is often found too flexible for use. This may be remedied by twining some cord round the hairs, next the handle, for a depth of about half

an inch, or so far as that the rest of the hairs are found to be stiff enough. This is what housepainters call *bridling*. Let the cord remain till the brush is worn down sufficiently to be stiff enough without it.

A new paint brush should be steeped in water for a day or two before being used; otherwise, the hairs are liable to come out during the painting.

To paint common articles.—The directions for painting in pages 120 and 121. ("To paint new woodwork," &c.) apply generally to work that one is particular about, such as parlour doors, certain parts of the woodwork of sitting-rooms, &c. But a great part—much the greater part, indeed—of the painting an amateur will have to do will require no such detailed care or nicety. For painting the common articles in and about a house, the only thing that will have to be done (except, perhaps, to remove dirt by washing) is to mix the paint, or buy a canister—whatever colour is wanted—and lay it on without further trouble—one or more coats as the case may be.

In this manner may be painted gates, posts, clothes poles, palings or railings—whether iron or timber—outhouse or kitchen doors, surbase and skirtings of parlours, window bars, &c. All such articles, if they are painted at regular intervals—say once in two years—will last four times longer than if left without paint. It is a matter of surprise to see, for instance, a gate or a paling rotting under the weather, when a few pennyworths of paint, which anyone could put on, would preserve it.

Whatever care or trouble is called for in what follows, there is no difficulty at all in painting these common articles. The work is so simple that any child can do it. I have seen a lady painting with great success about her own house. It is also very cheap: a pound of dry paint, which will take about ½ a pint of oil or turpentine to thin it, will weigh about 1½ lb. when mixed and ready for use, and will give a single coat to a surface 6 feet by 6, or about 36 square feet.

But when one aims at a better class of work, the following directions apply.

To paint new woodwork.—*Knotting.*—If there be knots in the wood they must be *killed;* otherwise they will show through the paint. There is a mixture called patent *knotting* sold for this purpose. Cover over the knots with a coating of knotting: when this is dry, it will be better—in order to make sure—to give another coat of red or white lead mixed with a little drying oil. When this is quite dry, rub it smooth with sand-paper or pumice stone. One can make his own knotting by mixing a little red or white lead with dissolved glue, so as to form a pretty thick paint. This answers quite as well as patent knotting. It should be applied hot, and it will dry in ten minutes or so.

Pumice stone is a light porous sort of stone, very useful for smoothing and polishing surfaces: sold in colour shops and druggists' at 4d. per lb. When about to use pumice stone as a rubber, one of the surfaces must be worn flat on a stone for the purpose. Red lead is sold in the form of a dry powder at 4d. per lb. White lead is sold, not dry like red lead, but mixed with refined linseed oil (raw), so as to form a thick paste: price 4d. per lb.

New wood should get at least three coats; and it usually gets four. The first coat is called *priming,* the chief use of which is to fill up the pores of the wood. It is usually made of white lead mixed with a little red lead—just enough to give colour—and in order that it may sink well into the wood, it is made very thin with drying oil alone, or with drying oil and a small proportion of turpentine—say 5 of oil to 1 of turpentine. But if the final colour is to be black or dark, the priming may be made up of white lead and vegetable black (see p. 125), half and half, which will give a lead colour. (For method of mixing different paints, see p. 123.) It is quite easy to make up priming of either kind; but it may be bought,

like all other paints, either in canisters, or in the form of paste.

When the priming coat is well dried, all flaws, nail holes, cracks, &c., are to be filled up with stopping putty (see "Putty"). This must be done after the priming, not before; for putty will not stick to raw wood.

The second coat may be the same paint as the priming—but not so thin; or it may be of white lead alone, if the final coat is to be white or light coloured: and it may have a little turpentine—say a third or a fourth part—mixed with the oil.

The third coat may have half and half oil and turpentine: the fourth and last coat may have one-third oil and two-thirds turpentine.

If the last coat is to be white, all the coatings after the priming must be white. If the last coat is to be coloured, the last coat but one ought to approach it, or be identical with it in colour: and it is usually made a shade darker. Each coat should be perfectly dry before another is laid on. For the mode of making up paints of different colours, see pp. 123, 125.

To paint old Woodwork.—The old paint should be first well washed. Remove with a knife all lumps, blisters, and hardened dirt, taking care not to injure the wood. If the face of the old paint is rough, it ought to be rubbed smooth with a piece of pumice stone, kept continually wetted, or with sand-paper (as described at p. 139). After this scrubbing, it should be well washed. Next fill up flaws, &c., with stopping putty, which should be let dry for a day or two before being painted over: if the putty shrinks in the drying, fill up with more putty. If there be any greasy spots, they should be washed over and over with turpentine to remove the grease: if the grease is not quite washed off it may show through the new paint. If the old paint be wholly removed from any part, that part should get a coat of priming.

In new work, as we have seen (p. 120), the first

coating, or priming, should be wholly or chiefly in oil. In old work it is the reverse; the first coat should be chiefly in turpentine, for turpentine tends to prevent greasy spots from showing through.

The first coat is composed of the same *pigments* as for new wood (p. 120), namely, white lead with a little of either red lead or vegetable black; it is to be mixed in with one third drying oil and two thirds turpentine. It is quite easy to make this up, following the directions given at page 123. Two coats more will probably be enough, which may be put on in the same way as the last two coats on new wood (p. 121).

Crossing.—In all painting—whether on new wood or on old—steps must be taken to insure that no marks are left after the brush. This is done by what is called *crossing:* that is, after the brush has been rubbed in one direction over a certain part of the surface, it is then rubbed in a cross direction; and this is done till all brush marks left after the first rubbing are smoothed away. The final rubbing should be with the grain of the wood: it must be done very lightly and softly till all marks across the grain are quite obliterated; and great care must be taken that no new marks are put on.

Outdoor and indoor painting.—Paint made wholly or chiefly in turpentine, i.e., flatted paint, will not stand the weather. Outdoor painting must therefore be chiefly in oil: or if flat, it must be varnished over (p. 133) to preserve it. On the other hand, flatting—either varnished or not—is generally preferred for indoor work; for the peculiar gloss of oil paint does not look well indoors; and flatting looks much better.

It is also to be observed that white paint, or indeed any light coloured paint, if formed wholly or chiefly of white lead and oil, is liable to get discoloured—becoming yellowish—in the air of a room, especially if it is exposed to smoke.

Flatting.—It has been already stated that paints

mixed in oil dry with a gloss, and that those mixed in turpentine dry flat (p. 116). Indoor paint is often flatted, and when well done it looks very beautiful. When painting is intended to be flat, all the coats except the two last may be put on according to the directions already given pp. 120, 121.

The coat preceding the flatting should be much the same in colour as the flatting itself, but a little darker; and it may be rather thicker than ordinary paint. It must be very smooth when dry—the smoother it is the better will be the flatting. This coat is therefore always in oil, which gives a gloss; and if the coat under it (i.e., the last coat but two) shows the least roughness, it should be rubbed over (when quite dry) perfectly smooth with fine sand-paper.

It is of course necessary that one coat of paint should be quite dry before the next is laid on. But in the present case—when the last coat is to be flat—the preceding oil coat (the last coat but one,) though it must be dry, must not be so dry as to be downright hard. For when it is slightly soft the flat coat will to some extent incorporate with it, and will therefore produce a better effect.

To make flatted paint of any colour.—Mix with the white lead paste the necessary quantity of colouring pigment, according to the directions below. Thin for use with turpentine alone—the oil already in the paste will be enough. This paint will dry flat.

Mixing Paints.—All the various colours are formed by due mixture of the primary colours, red, yellow, and blue, or of the secondary colours formed from them. An amateur will not often have to mix his own colours; for wherever paints are sold at all, the different colours are commonly sold ready mixed, so that you can usually buy any colour you want in any one of the three forms (p. 115). Nevertheless, as occasions for mixing may arise, a short section on this part of the subject may be of use.

When two colours are to be mixed, no matter in

what proportions, this is the way to do it. Make each separately into a perfectly uniform paste with oil: then mix them, and beat up the mixture till the whole is quite smooth and uniform. Add oil or turpentine or both, as the case may be (p. 116), stirring all the while, till the paint is thin enough for use. *Never mix by sprinkling the dry powder of one paint on the paste of another:* if the mixture is done in this way, some little lumps of the dry pigment will remain unbroken till the moment of laying on the paint, when the brush breaks them and makes a great daub. When mixing in this way, trial may be made whether you have the proper shade or not, by putting a little of the paint on a bit of wood to judge of the tint. But observe, that oil and turpentine paints dry dark, i.e., they are a little darker when dry than when wet.

Simple colours.—I shall now describe the most important of the *simple* colours, i.e., those formed from a single pigment, and then show how to obtain the most important of the compound colours, formed by mixing the simple pigments. (N.B. After the name of each pigment, is given in a parenthesis the price per lb.—except where per oz. is mentioned).

White.—White lead (4d.) is the pigment almost always used. It is sold as a paste (as already stated, p. 120), made with the finest raw linseed oil: boiled oil would spoil the colour. When preparing it as a white paint pour in a small quantity of turpentine alone (if the paint is to be flatted), or of turpentine and oil, and mix till the whole is quite uniform: then pour in more and mix; and so on till the paint is thin enough for use. Drying oil cannot be used here, for the reason given above. If raw linseed oil alone were used, the paint would take a very long time to dry: turpentine is therefore mixed in with the oil (p. 116), either half and half of both, or two of turpentine to one of oil. Even when turpentine is used with raw oil, the paint will dry slowly. If it is

necessary that it should dry moderately quickly, a little patent driers may be mixed with it—say ⅛ of an oz. for every lb. of white lead. But with white paint it is better to avoid driers; for however used, they tend more or less to discolour white or light paints.

Black.—Lampblack (4d.), vegetable black (6d.), ivory black (4d.), blue-black (2d.) The first two dry slowly, even with drying oil, and a little driers may be used.

Red.—Red lead (4d.), vermilion (3s. 6d.), Indian red (8d.)

Yellow.—Chrome yellow (1s.), king's yellow (6d. per oz.), Naples yellow, yellow ochre (2d.), raw sienna (8d.)

Blue.—Prussian blue (3s. 6d.), ultramarine (1s. 6d.), French ultramarine (1s. 6d.), indigo (4½d. per oz.)

Brown.—Burnt sienna (8d.), burnt or raw umber (8d.), Vandyke brown (8d.), Spanish brown (2d.)

Green.—Emerald green (1s.), verdigris (4d. per oz.), Brunswick green (4d.)

Orange.—Chrome orange (1s.), orange ochre (1s.)

Compound or mixed colours.—The following are some of the most important compound or mixed colours: white lead is the basis of all. The particular tint produced in each case depends on the proportions of the ingredients, and must be regulated by trial, and according to taste.

Buff.—White lead and yellow ochre.

Cream colour.—The same as buff, but with much less of yellow ochre.

Fawn.—White lead and burnt sienna: or white lead, burnt umber, and Venetian red.

Straw colour—White lead and chrome yellow.

Salmon colour.—White lead and Venetian red.

French grey: lilac.—White lead, lake, and indigo: or white lead, Prussian blue, and Indian red.

Bluish grey.—White lead and lampblack: or white lead and blue black.

Brownish grey.—White lead, Indian red, and indigo.

Stone colour.—White lead and yellow ochre: or white lead and raw or burnt umber.

Lead colour.—White lead and black of any kind.

Orange.—White lead and French yellow.

Oak colour.—White lead, yellow ochre, and burnt umber.

Green.—White lead, burnt umber, and indigo.

Pea green.—White lead and Brunswick green.

Sky blue.—White lead and Prussian blue.

Painting on plaster.—The walls of rooms are often painted instead of being either papered or distempered. Painting is more expensive than either papering or distempering (unless the paper be of a very superior kind): but it has a hard surface, is very lasting, and will bear washing. It is obvious that walls cannot be painted unless they are well and smoothly plastered. In painting the interior of a room, the last coat is always flat (p. 122), for glossy paint does not look well on the walls of an apartment.

If the walls have been papered, the old paper must be removed in the manner shown at p. 142. The walls must in all cases be washed thoroughly clean; and when dry, must be smoothed with sand-paper as for fine distempering (p. 139). The walls must be perfectly dry before beginning to paint.

New plaster, or old plaster that has not been oil-painted before, requires at least four coats: and it usually gets five. In what follows, we shall suppose four. The first coat is merely a grounding to fill up the pores of the plaster: and the second coat is to some extent the same.

First coat: white lead and drying oil, made thin that it may soak into the plaster. Second coat: white lead with drying oil and turpentine, half and half, rather thin also. The remaining two coats may be put on in the same manner as the last two coats of flatting, as described at p. 123: and the same precautions as to smoothness mentioned there must be adopted here also

If the plaster is very absorbent it may be necessary to give two groundings in oil: in this case there will be five coats, the last three being the same as above.

The interior of a room is generally painted some light or moderately light colour: and any colour may be chosen to suit the taste.

It may be remarked that the walls of a room should not be painted unless the plaster be quite dry. Certain paints are prescribed indeed to keep out damp: but they are merely temporary expedients. If the wall admits damp, there is no real cure but to remove the cause from the outside, by cementing, or plastering, or weather-slating.

Outside walls as well as inside are often painted. But the final coat here must be in oil, for the reason already given (p. 122). With this exception, outside walls are painted in the same manner as inside.

Various practical hints.—Never paint wood when it is wet or moist: wet wood painted over is sure to rot. Rotted bits should not be painted over; the rotten parts should be cut out, and the openings filled up with wood, or putty, or both.

If a paint brush after being used is to be put aside for a day or two, press out the paint as much as possible against the side of the paint pot, and let the brush stand in water till next wanted. But when the job is finished and the brush is to be laid by for a long time, wash it well first with turpentine, and afterwards with soap and water and a little soda: dry it and put it aside wrapped up in paper or cloth.

If the paint pot with some paint remaining in it has to be laid by for a considerable time, fill up the pot with water, and let it stand so. The water will exclude the air and keep the paint in good condition for a long time. When using it next pour off the water. If the pot be put by without this, the paint becomes hard and tough and quite useless.

Cleaning old Paint.—When the paint of timber work has got dirty, it may be cleaned, so as some-

times to look almost as if new. Wash it with soap and water in which a little washing soda or pearl ash has been dissolved. The soda or pearl ash removes grease: the soap and water will remove all other dirt.

CHAPTER XI.

STAINING AND VARNISHING.

Staining.

Nature and uses.—A stain deepens the colour of wood; in most cases it does not hide the grain; and it leaves no coating on the surface like paint. The inferior kinds of wood, such as pine, can be made, by staining, to resemble the better woods, such as mahogany, walnut, &c.: and whether this is so or not, a stain always takes away the raw look of wood, and gives it a warm finished surface. Stains can be used in a great many cases where painting would be unsuitable, as in a clothes-rack, a writing desk (p. 131), a picture frame, the boards of a floor, (p. 131). &c. And while staining is so useful, it is one of the easiest and cheapest handicrafts that an amateur could practise.

Different kinds of stains.—The following are the principal stains:—mahogany, rosewood, walnut, satinwood, oak, all so called because they give the look of these woods: there are also black (or ebony), brown, and red stains. The greater number of these may be easily made up by buying the ingredients; but it would be in most cases only a waste of time to do so; as all ordinary stains can be bought cheaply at every good oil and colour and drug shop.

The liquid in which stains are dissolved is generally water; but spirits of wine, turpentine, and oil are sometimes used. Water stains are the most convenient; for if the stain be too strong or too dark in

colour, it can be weakened and lightened by mixing a little water with it. Water stains and spirit stains dry flat (p. 116) and will therefore require to be varnished over. The varnish, however, cannot be put on directly: it is necessary first to give a coating of size. The whole operation of staining therefore consists of three processes :—1. washing the surface with the stain; 2. sizing; 3. varnishing.

To stain wood.—The wood must of course be planed smooth. After planing, it must be well rubbed over with sand-paper—first coarse, then fine—till the surface is perfectly smooth. Then all dust left by the sand-paper is to be wiped off with a brush or a soft cloth.

The stain.—The stain—as much as is wanted—may be poured out into a saucer; and it will be better, if possible, to apply it hot. It may be rubbed over the surface with a paint brush, or in the absence of a brush, with a sponge or a piece of woollen rag. But the brush is the best for several reasons—among others, that the fingers are pretty sure to get stained when using sponge or rag. The rubbing should be with the grain, not across. The wood to be stained should be placed with its surface horizontal—if that can be done; if not, the stain should be laid on very thinly, o rit will run down in streaks and spoil the work.

Whatever depth of shade is wanted, it will be well not to attempt it at one washing. Better give a thin light coating first, and when that is dry, another, and if necessary a third, till the proper depth is attained; for every successive coat makes the shade darker. By working in this way, any spot that comes out lighter than the rest can be darkened to the general depth. Each coating will dry in an hour or less. If the liquid stain is too strong, thin it with water.

The size.—When the last coat of stain is quite dry, the size is laid on; any ordinary size will answer (p. 136). It is dissolved in the way described at the page referred to; and it should be used hot. If it is

to be applied with the staining brush, the latter should be first washed in warm water till quite free of stain. It will be better to apply the size like the stain itself; that is to say, two or three thin coats are better than one heavy one. When applying it, rub with the grain, and only in one direction—not backwards and forwards. If it is found too thick, thin with warm water. The size coating will dry in a couple of hours.

The Varnish.—When the surface has been sufficiently sized, and when the size is quite dry, then apply the varnish. Ordinary size, as I have said, and any common varnish (which is easily made, p. 133), will answer; but in the shops, a size and a varnish are usually sold to match the stain.

One pint of stain will cover from 60 to 80 square feet, according to the depth of shade required, and according to the absorbent quality of the wood. Soft woods will take more than hard woods. For a pint of stain there will be wanting about 2lbs., or say a pint and a half, of size; and about a pint and a quarter of varnish. This gives the cost of staining 60 or 80 square feet:—stain, 1s.; size, 1d.; varnish, 1s. 8d.; total, about 2s. 9d.

Staining is best done in a warm room; and if done out of doors, a dry warm day should be chosen.

Once wood is stained it will not need staining again. If it wants refreshing, wash the old varnish and give a new coat: this will make the surface look as well as when first stained.

Prices.—Stains are generally bought in a liquid state: the usual price is 2s. a pint; but they are also sold in small bottles at 6d. and 1s. each. The varnish usually sold along with the stain costs 1s. 6d. a pint: and the size, 1s. per lb.

Stains in powder.—There are stains sold in the form of dry powders; and in this way you can buy oak, mahogany, satinwood, walnut, rosewood, and ebony. They are sold in packets of 1s. each, and

upwards. To prepare them you have nothing to do but dissolve the powder in hot water; each packet will make from a pint to a quart of stain according to the strength required. These stains are very convenient; for you can make just as much as is wanted for the occasion. They are applied in the same way as the other stains, and are followed by size and varnish.

Oil oak stains.—There is an oil oak stain sold at 1s. 6d. a pint. It is to be got in three shades—light, medium, and dark. These stains do not absolutely require varnishing like water stains; but they will be the better for it. If they are varnished, the varnish may be laid on directly without sizing. There is this advantage in oil varnish, that it preserves the wood from wet like paint.

Staining floors.—The floors of sitting-rooms, when not carpeted, are often stained; or the middle of the floor is carpeted and a margin all round stained. The boards—if not already smooth—must be planed and sand-papered. The spaces between the boards should be filled up with thin slits fastened down by slender sprigs driven obliquely—the heads sunk with a punch. Finally, the floor should be well washed; and when it is perfectly dry the stain is put on. Any colour may be chosen to please the fancy; and either water stain or oil stain may be used.

The rest of the process—sizing and varnishing—is to be done in the way already described. Instead of varnish, beeswax and turpentine polish may be used, which requires no size; but it is not so lasting as varnish. It is prepared and applied as follows. Put into a pint of turpentine a small piece of beeswax—say 1 oz.—cut up into thin shreds; and place the vessel in an oven, or beside a hot fire, till the beeswax is melted. *Great caution is necessary, for it is easily set on fire.* Apply this all over the boards with a large rag; then go over it again with a dry clean scrubbing-brush, rubbing hard and

quick to bring out the polish. If the mixture gets too thick pour in some turpentine. If the boards, after the brushing, be finally rubbed over with a dry cloth, it will improve the polish.

The greater the quantity of beeswax the brighter the polish; but too much of it makes the floor so slippery as to be dangerous.

The polish here described is that commonly used for floor oil-cloths.

Varnishing.

Nature and uses.—All varnishes are made by dissolving the resins in spirit, turpentine, or oil. It is in general better to buy varnishes ready made when they can be got; for they will not cost much more than the separate ingredients, and they are usually better than those you make. But some are very easily made, so that one need not be quite dependent on the supply to be obtained in shops.

Varnish is simply laid on like paint, with a soft brush, and allowed to dry. There is a special varnish brush, which is broad and flat in shape: but any ordinary sash brush will do quite well.

Varnishes are used for a variety of purposes. For instance a coat of varnish will preserve paint for an indefinite time, provided the varnish be renewed whenever necessary. Prints and maps for school or study rooms are varnished, both to preserve them and give them a better appearance: outdoor gilding is sometimes varnished to protect it from the weather; plain timber in the inside of buildings is sometimes coated with varnish to preserve the colour and clearness of the grain, &c., &c.

Different kinds of varnish.—There is a great variety of varnishes, but the amateur may content himself with a knowledge of a few. Copal varnish (4s. a pint) is very hard and transparent, and is used for fine painting, gilding, &c. Wainscot varnish is used in house painting and papering. Oak varnish is

one of the most generally useful; it may be applied to paints, woodwork, furniture, and metals of all kinds: the best kind costs, 1s. 6d. a pint. Paper varnish is used for maps, engravings, tablets, &c.; it is quite pale and transparent, and costs 2s. a pint. Bruns wick black is an extremely useful common varnish. It may be used to colour anything black—timber, metal, plaster, stone, &c.; and when laid on moderately thick it will dry with an intense black varnish surface. Sold in jars of 6d. and 1s. each.

A good varnish for common use may be made by dissolving ¼lb of white resin, powdered fine (4d. per lb.) in ½ a pint of turpentine: let the resin be dissolved in the way described at page 134. This varnish may be applied to all painted articles whether wood or metal; and it will improve the appearance, and preserve the paint.

Sealing-wax varnish, which is opaque, is sometimes useful for coating metals, for making corks water tight, &c. It may be made by dissolving sealing-wax of any colour in alcohol or methylated spirit (sold by druggists—8d. a pint). Put the wax into the spirit, and let the phial stand in a warm place for a day or two, stirring it occasionally. This varnish, like all others, may be kept in a phial for any length of time.

To varnish a map, a diagram, or an engraving.—Paper varnish may be used. Mastic varnish is much better, and is used for fine engravings, &c.: but it costs 6s. 6d. a pint. Before the varnish is laid on, the map must be sized. An excellent size for the purpose may be made by dissolving clear white glue (1s. per lb.), or good gelatine (2s. 6d. per lb., or 3d. per oz.) in boiling water: nearly ½ an oz. of either glue or gelatine to half a pint of water. This, when cold, will be a jelly. When about to apply it, warm it until it is liquid: then apply with a brush. Give two or three coats—one coat to be quite dry before the next is laid on: each will take

about an hour to dry. The size might be made so strong that one coat would be enough: but two or three thin coats are better than one thick one, which is liable to crack. If the paper is very soft and porous, it may require more than three coats. If the paper be not sized enough the varnish will go through and leave oily-looking stains, so as to spoil the whole map. Before laying on the varnish, therefore, it is better to try it on a separate piece of paper. When the size is dry lay on the varnish.

If paper or mastic varnish cannot be got, an excellent varnish for maps, diagrams, &c., may be made in the following way. Dissolve ½ oz. of Canada balsam (a thick liquid, 4s. 6d. per lb., or 6d. per oz.), and ½ oz. white resin powdered fine (4d. per lb.) in about ⅙ of a pint of turpentine. Put the turpentine into a bottle, and drop in the rosin. Then heat the bottle near a fire, or by plunging it up to the neck in hot water, and shake it occasionally: the resin will dissolve in a few minutes. After this pour in the Canada balsam, which needs only shaking to mix with the rest. With varnish made in this way, and with size made of glue, I have seen both maps and diagrams beautifully varnished.

If a brush that has been employed in painting is used to varnish, it must be carefully washed, first in turpentine, and afterwards with water and soda: if any trace of paint remains it will spoil the varnish.

CHAPTER XII.

WHITEWASHING AND DISTEMPERING.

Materials.—For whitewashing and washing in colours, either lime or whiting may be used. Washing or painting with whiting mixed up with size, is commonly called *distempering*, and is regarded as

a finer kind of work than washing with lime. Where there has been any infectious sickness in a house, however, it is better to use lime, as it is a disinfectant, which whiting is not.

Whitewash brush.—The only tool absolutely necessary for this work is a whitewash brush. The best brushes are made of hair bound with copper wire, and cost from 3s. 6d. to 6s., according to size. There are inferior ones made of fibre, from ls. 6d. to 2s.: but the hair brushes are better value, as they do better work, and will last four times as long. A new whitewash brush ought to be steeped like a paint brush (p. 119), before being used.

Lime Whitewash.—To make common lime whitewash for outside walls. Put some pieces of lime into a vessel, and pour on it enough of water to slake it: cold water will do, but boiling water is better. When it is well slaked, pour in cold water, and keep stirring till there is a white milky liquid. When the lime is all, or nearly all, dissolved, let the course sediment fall to the bottom. Then lay the wash on the walls with the whitewash brush. During the work the liquid must be often stirred up, as the lime has a tendency to fall to the bottom.

Whitewash made from lime only, as above, easily rubs off and will not stand the weather long. But it may be made to stick by a little size (p. 136): the more size the firmer will the wash adhere. Half a pint of dissolved size to every gallon of the liquid whitewash—poured in hot and stirred up—will answer very well. The size tends, however, to injure the colour, giving a yellowish tinge; but this may be in great measure corrected by mixing in a little blue colouring matter as directed for distemper at p. 137. Instead of size, some use common salt—a pound to every three or four gallons of wash; but salt tends to discolour, and besides, causes the whitewash to change with the weather. Another usual recipe for limewash is: add to about 3 gallons of

limewash 1 lb. of common salt, and $1\frac{1}{2}$ lb. of sulphate of zinc (white copperas) This white wash dries hard and is not easily rubbed off.

For the way to colour whitewash, see p. 139.

Whiting and size.—White distemper is made with whiting mixed with water, size (to make it stick), and a little blue. As in the case of lime, the size injures the colour: this is corrected by the blue, just for the same reason that washing-blue improves the white colour of linen.

Whiting is a fine white powder, a preparation of chalk, used as here in making distemper washes, and for cleaning glass, silver, &c. It is sold by oil and colourmen, druggists, and chandlers. The best washed whiting is 3s. a cwt.: common kind, 2s.: but both may be bought by the stone. When bought in small quantities it generally costs much more in proportion.

Size is a jelly like substance, used by painters, paper-hangers, &c. When cold, as you get it in the shops, it is in the form of jelly. The best jellied size may be bought in any oil and colour shop for 6d. a gallon; and inferior size for 4d. a gallon. But only as much as is wanted for the time should be got, as it will not keep: it will putrify, and give forth an offensive smell in a few days. When preparing the size for use, put it into a vessel with a little water —just enough to cover it—and heat over a gentle fire till the water and size form one uniform liquid. The smaller the quantity of water used the stronger the size will be: so that it may be made of any strength required.

Size may also be bought in the shape of a dry powder; this is what is called *concentrated* size, which will keep any length of time: price 9d. per lb. It is prepared for use by being dissolved in boiling water, kept stirred from the bottom while boiling till all the size is dissolved. Half a lb. will make a gallon of strong size: but more or less water is used according to the strength required.

To make white distemper.—Put half-a-stone of the best whiting into a vessel, and pour water on it, stirring it up all the while. Let it rest for a couple of hours, or better, for a whole night: then pour off the superfluous water, and with a piece of stick beat up the wet whiting into a paste like cream.

Mix with this a little blue colouring matter of any kind—say an oz. or two of Prussian blue (p. 125). The blue is mixed much in the same way as colour pigment is mixed with white lead, and for the same reason (p. 123). First make it into a paste by mixing it up with water. Put into a bowl a little of the whiteing paste with this blue paste, and mix up till the whole is uniform and smooth. Mix this in the same way with a larger quantity of whiting; and lastly, throw this into the bulk of the whiting, and mix up as before.

Better add and mix the blue by trials. The right quantity will make the wash dry a beautiful white; but an overdose will give a distinct blue tinge, like too much blue in linen. Trial can be made by painting a little of the paste on paper, and drying it before a fire: if not pure white, add more blue; if too blue, add more whiting paste.

The next thing to be added is the size. Melt it with the proper quantity of water as described at p. 136: $2\frac{1}{2}$ or 3 pints of this melted size (or of that made by dissolving concentrated size,) may be used for the present quantity (half-a-stone) of whiting. The size may be added when it is just warm enough to be liquid.

This is the distemper. When cold it should be of the consistency of thin gum: if found too thick pour on some water, stirring it all the time.

To apply distemper.—This distemper is applied cold with a whitewash brush. When laying on, dip the brush often and do not take up too much at a time. The work should be done without splashing. While working keep the mixture well stirred, as the

whiting tends to fall to the bottom. If it is done in winter, better keep the room warm with a good fire while it is going on. If it is in summer, keep the windows and doors closed during the work, that the distemper may not dry too quickly under the brush; but once the work is done the sooner it dries the better, so that all the windows and doors should be thrown open.

The quantity of distemper here made will cover about 500 square feet with a single coat. If a smaller area has to be distempered, of course smaller quantities of the materials will be used.

If size cannot be got, glue will answer quite well as a substitute, white glue being best. Let it be made as if for carpentry (p. 44), and let it be mixed with the whiting in the very same manner as size. It is stronger than size however, and about half the quantity will be enough.

Common potato starch may be used also instead of size; and it has this advantage, that it will not injure the colour; but it does not give so good a hold as size or glue.

Preparation of walls.—Before laying on distemper or whitewash, it is generally necessary to clean the walls. If they be not very dirty, or very much discoloured, and if the old wash is moderately smooth, a good dry scrubbing with a coarse cloth will be enough. But if the old whitewash is smoked, or dirty, or rough, it should be removed. This may be done with an old whitewash brush, and a vessel of water. Sop the old whitewash in one particular place till it is well soaked; it is now soft, and can be easily scraped off with a strong old knife, or a scraper. Proceed in this way from place to place till the whole is cleared off. Whenever the water becomes very dirty it should be changed.

Next, fill up all cracks, holes, and flaws with a paste made in this way. Take some plaster of Paris (for which see Chap. xix.) with two or three

times as much of whiting or slaked lime: wet them and mix them up till they form a paste. Fill up the flaws quite smooth with this, using a large knife or a small trowel. Make only a small quantity at a time, and work quickly, for the plaster soon sets. If any is left it cannot be used again, and may be thrown away.

Where very neat and good work is required, as for instance, where a parlour is to distempered, extra care must be taken to smooth the walls. Let them be first cleaned or washed as above. When they are thoroughly dry, rub them over with coarse sandpaper stretched over a flat piece of cork, or over a bit of board—about 4 inches square—with cloth between the sandpaper and the board. Then go over them again with fine sandpaper; after which fill up flaws and holes. If the walls be very porous and absorbent, it will be better to first give them a coat of size to fill up the pores, as is done for papering (p. 141). And lastly, for fine work of this kind, the distemper, before being laid on, might be heated (if necessary), and strained through a fine strainer or a piece of canvass.

In a kitchen, the bottom of the wall should be coloured black nine inches or a foot high all round. This may be done with Brunswick black (p. 133). But a better colouring stuff may be prepared by mixing some drying oil and turpentine—half and half—with lampblack, till there is a black liquid: but this must be varnished. Apply with a large brush; any old whitewash brush will do.

Colouring.—Either distemper or lime wash may be made of any colour required. The pigments used are the very same as those used for painting, as described at p. 125, except only that whiting or lime is used as a basis instead of white lead, and size instead of oil or turpentine. When colouring distemper or lime wash, the colour pigment must first be made into a paste *with water*, and afterwards mixed in, much in the same manner as described for

blue at page 137. The precaution given as to mixing paints (p. 124) may be repeated here:—Never mix the dry powder of any pigment with the paste of whiting or lime, or of any other pigment.

CHAPTER XIII.

PAPER HANGING.

How room paper is sold.—English room paper is always 21 inches wide; and it is sold in rolls, each of which is called a *dozen* because it contains 12 yards. A dozen therefore contains 63 square feet. On each side of the pattern (which itself is 21 inches wide), there is a dark selvage or margin of half an inch or so. There are also French papers, which are only 18 inches wide, each roll being about 9½ yards in length.

Almost all papers have an upper and a lower end; as for instance those with figures of animals or plants. The outside or loose end of the roll, as you get it in the shop, is always the upper end.

Cost and choice of paper.—Room papers vary greatly in price. Bedroom papers run from 2d. a dozen upwards; a fair bedroom paper may be bought for 6d. a dozen. Sitting-room papers run from 1s. upwards. There are infinite varieties of pattern and colour, so that a purchaser has ample choice.

It is easy to calculate the quantity of paper required for any particular room, and the expense. Suppose a bedroom 14 feet by 10 feet by 9 feet high. The area of the four walls, deducting say 70 square feet for door, window, and fire place, will be 362 square feet: which divided by 63 gives as quotient, 6 (nearly), the number of dozens that would barely cover the room. But something must be

allowed for waste; and some paper should always be kept for repairs. For if at any future time patches become soiled or damaged—which is pretty sure to happen—it may be impossible to get the same paper again; and the precaution of keeping a little over may obviate the necessity of re-papering the whole room.

It will be well therefore to get 8 dozen for the present room. This, at 6d. a dozen, will cost 4s.: and as there is no more expense if the buyer himself put up the paper, this room will be papered cheaply enough. At 1s. a dozen, the paper for a fair sized sitting-room will cost from 8s. to 10s. With the very cheap papers, both rooms could of course be papered for much less: but very cheap papers ought to be avoided. The moist paste makes them so soft that they will often fall in pieces when you are putting them up; besides they never look well, and will soon grow shabby.

Preparation of walls.—When newly plastered walls are about to be papered, they must be sized to fill up the pores. If this were not done, the plaster would, in course of time, soak all moisture out of the paste, and the paper would be apt to peel off. Melt the size with a little water, as shown at p. 136, and apply it all over the wall with a brush. One gallon of made size will coat about 180 square feet. If the walls, instead of being newly plastered, have been distempered, or whitewashed with lime, the old coat must be taken off, and the plaster laid bare, in the manner shown at p. 138. After this the walls must be sized.

If the walls have been already papered, the old paper should be well dusted, and all loose pieces torn off. But it is far better to remove it altogether; and this is quite necessary in case there has been any infectious sickness. In this case also, the old paper after having been taken off, should be burned, not thrown aside: and the ceiling should be whitewashed

with lime (p. 135), the old whitewash or distemper having been washed off.

The old paper is removed in this way. With a whitewash brush and a vessel of warm water, wet a part of the paper till it is well soaked. This will soften it; and it can be easily peeled off with a scraper, or an old plane-iron, or with a strong smooth-edged old knife. But take care not to injure the plaster. In this way wet and peel off part after part, till the whole room is cleared.

When the paper is off, give the walls a final washing with the brush in clean water, warm or cold, to remove all loose scraps. Now pull out all old nails, and fill up smoothly all cracks and fractures with the paste mentioned at p. 138. If fractures, cracks, or holes, are not filled up, but are merely covered over with the paper, they will afterwards show through, or the paper will get broken—disfiguring the room in either case. Lastly, it will be better to size the walls, though this is not absolutely necessary.

Paste.—The paper is fastened to the wall with flour paste, which is made in this way. Blend two or three spoonfuls of flour in a little water till it is quite free from lumps: pour water on this, stirring all the time till there is a milky liquid. Throw in also a little alum—say as much as fits on a penny piece. Put the mixture on the fire, stirring all the time till it comes to a boil. When it has boiled a minute or two remove it. It is to be used cold. When cold it should be of the consistency of thick gruel, or thin stirabout: if it be too thin it will not hold: if too thick it will not spread easily. The proper proportions of flour and water will be learned after one or two trials.

It will greatly strengthen paste if a little glue or size be added—say a fifth part. The glue or size should be dissolved in the usual way (pp. 44 and 136), and poured hot into the boiling paste, which is to be kept stirred all the time.

The paste described here, with or without glue or size, will answer all ordinary purposes for which flour paste is used. But see p. 220 for a finer paste.

Cutting the lengths.—The paper must be cut in strips or lengths to correspond with the height of the room. But as the pattern must be matched when placing the strips side by side on the wall, the pieces must be cut from the roll in such a way that the scissors will always run through the same part of the pattern. Thus, it generally happens that the lengths have to be cut a little longer than the height of the room, and the excess is so much waste. It is well to remark that the smaller the pattern the less the waste.

Suppose a room is 9½ feet high, for which you buy a paper with a pattern that repeats itself in exactly 10 inches. Here you have to cut the strips 10 feet long, leaving 6 inches waste on every strip. The whole roll will in this case give three lengths and 6 feet over. Two of these 6-foot pieces will make one length by joining in the middle (still matching the pattern)—and here also is a little waste. Or the 6-foot remnants may be kept over for short spaces over windows, fire-places, and doors; or some of them may be kept for future repairs.

In cutting out the first piece, take care that the top be cut across in an appropriate place; for all the other pieces must follow this. It would be very wrong for instance, to run the cut through the middle of a flower. You must of course, take your chance for the bottom; but it is of no consequence how the cut runs there.

According as the lengths are cut, they are laid one over another, on the floor, or better, on boards or tables placed for the purpose. In the case supposed above, the pieces are all cut 10 feet long in the first instance; and the superfluous bit of 6 inches is cut off from the bottom after each piece has been put on the wall. In laying the paper on the wall, you

[illegible] is repeated. If [illegible] other selvage [illegible] you begin the [illegible] round to the [illegible] is pretty certain [illegible] even, and will [illegible] the pattern will [illegible] begin at the [illegible] of the room, [illegible] fire-place, &c.; [illegible] occurs in a conspicuous place, [illegible] and is always offensive to the eye.

The paste is put on the back of the paper. For this purpose the piece is laid face down on some clean level surface, such as two tables laid together lengthwise. The paste is laid on with a broad brush, such as a small whitewash brush, or a good-sized paint brush. It must be spread evenly and not too thickly, else it will squeeze out at the edges. The paper, if cheap and thin, may be put on the wall the moment the paste is spread; but if it be thick, it should get two or three minutes to give time for the damp of the paste to soak through.

Bring the pasted piece to the wall, using both hands; mount a small ladder or a table, and holding the piece by the two corners, see that it hangs right with its edge along the corner. When it appears to hang straight stick it to the wall at the top. But before

attaching the rest of it, and while it still hangs loose, it will be better to try it with a plumb line—a heavy button or something of the kind, tied at the end of a thin cord: for it is quite necessary that the pieces be perpendicular, whether the corner of the room be so or not. Indeed the better plan would be to use the plumb line first, drawing a pencil mark all along the vertical line as a guide for the first piece.

When the loose piece hangs quite vertical, lightly press it all along down the middle with some clean soft substance, such as a muff of soft linen, a dry brush, &c., so as to stick the paper to the wall. It should be merely tapped or pressed along, not rubbed; for rubbing might smear the colours of the moist paper. Then, beginning at the top, tap lightly with the muff from centre to right and left downwards, removing as far as possible all wrinkles, till the whole piece catches closely to the wall. Very small wrinkles may be disregarded as they will most likely disappear in the drying. If there is a waste bit at the bottom (as in the case above supposed—6 inches), mark the part to be cut off by running the point of the scissors all along in the angle, then cut it, and stick on the loose part.

A beginner will experience some difficulty in lifting the paper from the table after pasting, and conveying it to its place on the wall: but a little practice will get over this. The easiest plan is to fold the piece in two before lifting it: then when the top is fixed, let the piece fall its whole length, guiding it down very gently with the hand. The paper must be handled very tenderly, for the paste makes it fragile and easily torn. Indeed very cheap papers will sometimes break in two by their own weight, and by the weight of the paste, when lifted from the table.

The next piece is managed in the same way; its cut edge overlapping the uncut selvage of the first. The edges must of course exactly coincide, and the

pattern must be carefully matched. The matching of the pattern is done at top: the coincidence of the edges is directed by the eye looking down from above. After putting on two or three pieces it will be better to test again by the plumb line, and if there is any slight departure correct it, which, as it will be very small, can be done without deranging the pattern.

When pressing home the pieces, if the paste should squeeze out at the edge, remove it at once with a moist sponge or clean rag; but do so delicately, so as not to smear the pattern. If any piece gets hopelessly wrinkled or spoiled, better sacrifice it by tearing it off. Finally, a beginner is advised to try his hand on a room he is not particular about: the experience of this will enable him to do the next room better.

Papering timber sheeting.—Sometimes timber sheeting such as that described at p. 104 has to be papered. If the paper be laid on the bare boards it is sure to crack at the joinings, if the timber shrink even ever so little. To prevent this, which would utterly spoil the whole paper, paste narrow strips of strong calico along the joinings, and along any cracks: this must be done with very strong paste. If it is found hard to make the calico catch with paste, it may be nailed with the shortest tacks that can be got, having perfectly flat heads. The calico should be nailed on while wet: when it dries it will be quite tight and stiff. But paste is better than tacks. If after putting on the calico, the surface looks rough, strips of ordinary paper of any kind may be pasted over it, so wide as to extend a little beyond it on each side. When this is dry put on the papering.

Hall paper.—Papers for halls and passages are often imitations of marble or wood: these must be always varnished, which is done after putting them up, and when they are quite dry

Oak varnish, which is easily made (p. 133), will answer as well as any other. The paper will first require two coats of size; and when these are quite dry, the varnish is laid on. Two coats of varnish are commonly required.

Tradesmen have a special varnishing brush, which is broad and flat in shape. But in the absence of one of these an ordinary paint brush will answer very well. Only it must be washed perfectly clean from paint, first in turpentine, and next in soap and water. If any paint remains it will spoil the varnish.

If paper be varnished in this way, it will bear washing when it gets soiled or discoloured. It may be washed with soap and water, or with tea-water: but this must be done lightly and cautiously.

The paper may be re-varnished whenever it seems to want it. If the varnish has been completely rubbed off from any particular spots they should be sized as at first. If hall paper is properly varnished, and the varnish renewed when wanting, it will last and look as fresh as at first for very many years.

CHAPTER XIV.

GLAZING.

Different kinds of glass.—There are several kinds of window glass—plate, crown, sheet, &c. Sheet glass is the kind in common use: it is of various thicknesses, and the thicker it is the more expensive. The common glass of the shops, used for glazing the ordinary run of windows, costs about 3d. a square foot; though retail dealers often charge much more.

Taking size of pane.—When a pane of glass is wanted, it is generally the safest and most covenient plan to get it cut to size in the shop, which should

add nothing to the price. Better bring the size marked on a little rod or lath, than give it in inches and fractions. If the exact length and breadth of the inside of the rabbet be marked on the rod, the glass cutter will cut the pane a little smaller to make it fit easily. This is a matter that should be looked to, for if a pane is even the least bit too large it gives great trouble in putting it in.

However, any one who often repairs or replaces broken panes will find it very convenient to have either a diamond or an American glass cutter.

Glazier's diamond.—A glazier's diamond consists of a small diamond set firmly in gold at the end of a handle (Fig. 65).; the edge in which the diamond is set runs obliquely across the lower end of the handle. The diamond is the hardest of all known substances; and when drawn along the surface of glass with moderate pressure, it will leave a clean cut along which the glass will easily break. The cheapest glazier's diamond will cost 10s. new: but a second-hand one may be bought for 5s. or 6s.

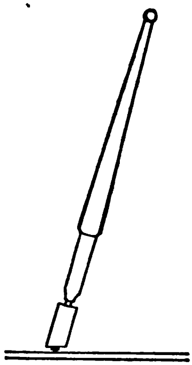


FIG. 65.

For cutting rectangular panes of glass, a T-square is used, which enables one to run a cut at right angles to the edge. The T-square will cost from 1s. up, according to size. But with a little management—using the carpenter's square or any other *square* angle—the cut may be run at right angles without the T-square.

How to cut with a Diamond.—It takes some little practice to cut with a glazier's diamond. The glass should lie on a perfectly flat surface: when cutting, draw from left to right, holding the handle all through, so that the edge in which the diamond is

fixed shall be always parallel to the surface of the glass. Fig. 65 shows the proper position of the diamond when cutting.

Begin the cut slightly within the left hand edge of the glass, to avoid injuring the setting of the diamond by rough contact with the sharp glass-edge. It is not necessary to lean heavily: once the continuous scratch on the glass is heard it is enough—the cut will then be all right. If on inspection the cut is found to be imperfect, do not go over it again, but make a new cut at some little distance inside it.

Before attempting to break, strike three or four smart light taps with the metal part of the diamond on the under side, just beneath the near end of the cut: then break by catching between the finger and thumb of each hand, and using some force, that end of the cut where it runs to the very edge.

American glass cutter.—The Amerian glass cutter costs only 1s. It is much the same in shape as the diamond, consisting of a very small wheel made of the hardest steel, placed at one end of a handle. The circumference of this wheel is a sharp edge, and it revolves freely on an axle. When it is rolled on the glass with some pressure, it makes a cut along which the glass will break. The glass must lie on a level surface, and when the cut is made, it must be tapped underneath, before breaking, in the same manner as when a diamond has been used. When one becomes dexterous in using the glass cutter, it is almost as sure as the diamond.

How a pane is fastened.—A pane of glass rests in a rabbet all round its edge in the sash; and it is fastened in with putty at both sides, the putty forming a bed underneath and a smooth bevel on top. Soft putty (p. 152) should always be used in glazing: for when hard putty is put on, there is great difficulty in taking it out afterwards in case the pane has to be replaced; and with the utmost care the wood-work sometimes gets injured.

To put in a pane.—When glazing a newly made sash, the wood should first be painted; for if putty is put on unpainted wood, the pores will gradually suck the oil dry, and after a little time the putty will fall off.

In replacing a broken pane, the first thing to be done is to remove the old putty and broken glass. The dry old putty is "hacked out" with a "hacking knife," which has a strong angular point at top: price about 6d. But any old knife will do, if the top of the blade be strong and sharp: or if not, it might be broken off right across at top to give it an angular point. An old chisel past its use will answer equally well.

With some one of these, and a small hammer, hack out the old putty. If it be soft putty it comes away easily; but if hard it gives trouble, and care must be taken not to injure the sash, or break the adjoining panes. When the old glass has been removed, hack out the putty at the under side, till the rabbet is quite clean.

If the old putty is unusually hard, it may be softened by being rubbed all along with the top of a poker (or any such piece of metal) heated till it is just beginning to be red. The heat softens the putty, as mentioned at p. 152, so that it comes away easily.

We suppose that the pane is ready cut to size. When the rabbet is quite clear, spread putty pretty evenly along the bottom of it, all the way round: this may be done with the thumb; but beware of small particles of glass. Put the pane down on this, and gradually press and work it down with the fingers of both hands, till it is well bedded. Then put putty on top all round at the edge of the pane, so as to fill up the rabbet; after which even it with the top of a knife, removing waste putty as you go along.

Next cut away with the point of the knife the superfluous putty that has been squeezed out by pressure at the back of the pane.

Lastly, smooth and even the putty at both sides, wetting the knife occasionally to make it run smoothly, and taking care to make the putty in the bevel quite straight along the glass. This bevelled putty should not project out on the glass further than the edge of the rabbet at the back.

There is a putty knife for this purpose, sold for about 6d.; but any knife that has a strong small rounded top will answer very well.

It is, of course, not necessary to take out the sash to put in a pane, unless it be in a dangerous or awkward place.

If the pane be large, the soft putty bevel in front may not be strong enough to hold it in place. In this case, after the pane has been bedded in the under putty, it is "sprigged," i.e., four small headless tacks are driven into the sash over the glass at the middle of the four sides. Make a good hole with a small awl, not too tight on the glass; hammer in very gently with a small hammer, or the side of a chisel or turnscrew—just enough to fasten the sprig and no more; and take great care both in boring and hammering. I once saw a tradesman break a large pane of glass when sprigging. The putty will cover the tacks.

When the whole thing is finished, if the putty is to be coloured, colour it brown or reddish by rubbing it with some colouring matter—red lead, Spanish brown, dragons' blood, &c. It is better, however, to paint the putty, as this tends to preserve it from cracking.

If putty, after it has grown hard, cracks and lets in the wet, it is better to remove it and put in new putty. Or cracked putty may be painted first, and then, while the paint is wet, rubbed over with new putty so as to fill up the cracks.

Crown glass is often found to be not quite level. When a pane of this kind of glass is put in, it is usual to turn the convex side out.

If a small hole is broken in a pane of glass, it may be mended with a bit of glass a little larger than the hole, which is stuck on the inside of the pane with one of the cements mentioned in Chap. xix. The cement will hold the piece in for a long time, and if it falls off it is easy to put it on again.

Putty.—Common putty, or glazier's putty is made of the best whiting (p. 136) and raw linseed oil kneaded together. It may be easily made by simply mixing the materials; or it may be bought at 1d. a lb. This is what is called soft putty: for it never becomes very hard, and is consequently easily removed when old and dry.

Putty may be made of any particular colour by mixing in a little colour pigment (p. 125).

If putty is put by till it grows hard, it may be softened by heating it and kneading it up while hot, mixing in a little linseed oil.

Hard putty, called also filling putty, because it is used for filling up flaws in wood before painting, is made by mixing about three parts of soft putty with one part of white lead, or red lead, if red coloured putty is preferred. The putty made in this way becomes almost as hard as a stone. It is best to make your own hard putty by buying soft putty and mixing white or red lead with it in the proper proportion.

CHAPTER XV.

FRAMING AND HANGING PICTURES.

Framing Pictures.

Kinds and prices of moulding.—Gold coloured picture frames are of two kinds: those that are hand gilt in the usual way with gold leaf, and those made of German moulding. German moulding consists of wood covered with a white composition or *compo*, stamped and moulded in various patterns, and

covered with silver or some other metallic leaf, which is lacquered so as to give it a bright gold colour. The very best kind is much cheaper than gilt moulding, and looks almost as well: an uninstructed eye could scarcely detect the difference between gilt and good German moulding. Moreover it will keep its colour for years without perceptible change, like gilding.

There are several qualities of German moulding. The best or *extra* quality, as it is called, is covered with silver leaf, as stated above. In the next quality, or what is called *best*, tinfoil is used: this makes a very good moulding, though not quite so brilliant as the *extra*. There are inferior and cheap sorts in which colouring materials of various kinds are used—such for instance as Dutch metal, bronze dust, &c ; but all these soon fade and grow shabby, and should be avoided.

German mouldings are also made in imitation of walnut, rosewood, oak, &c.

Besides gilt and German, there are maple, oak, and rosewood mouldings, and mouldings stained black and varnished, so as to resemble ebony; some also partly black and partly gold, and some are veneered. All these are sold in strips, generally 9 feet long, varying in width from half an inch to 3 inches or more; and the price varies from 1d. a foot to 3s. a foot or more, according to the width and the excellence of colouring and pattern. Plain German moulding $\frac{1}{2}$ inch wide will cost 1d. a foot: $\frac{3}{4}$-inch wide $1\frac{1}{2}$d a foot—both *extra* quality. One inch wide, plain moulding, *extra* quality, will cost 3d. a foot; *best* quality, 2d. A pretty pattern, an imitation of carving, as bright as real gold, 2 inches wide, may be got for 6d. a foot *extra;* or 4d. a foot *best.* From those examples some idea may be formed of the prices of wider mouldings.

Moulding for picture frames has always a rabbet on the back (see B, Fig. 5, p. 14), for the reception of the glass and the picture.

In any picture frame maker's, or in any of the large shops in cities where they combine the businesses of glazing, oil and colours, and general hardware, the amateur can inspect patterns, and choose for himself.

Requisites for framing.—In order to frame a picture you must have 1. the moulding for the frame; 2. a square of glass the size of the picture; 3. some thin boards to place at the back of the picture; 4. brass rings and coloured cord for hanging the framed picture.

To cut the pieces.—The part of the process that calls for most judgment is the cutting off from the strip of moulding the four sides of the frame; for they must be mitre-cut truly and smoothly, and the opposite sides of the frame must be exactly equal in length; otherwise the four pieces will not form a rectangle (or *square* frame), and indeed will not fit together at all.

To cut out the four pieces. Measure along the rabbet, the length AB of the picture (Fig. 66) and put pencil marks at the two points A and B. The point B must be far enough from the end CD, to allow room for the mitre-cut BD, with a little excess to allow for waste in cutting. Measure off from A a like distance EA, and cut the piece right across at E. Then mitre-cut the two ends (p. 49).

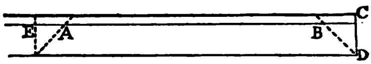


FIG. 66.

In the same way measure, cut off, and mitre another piece *exactly* the same length as the first; after which, cut and mitre two other pieces to correspond with the width of the picture. If the mitring has been well done, the ends will fit exactly, so that no opening can be seen between them.

In mitre-cutting picture moulding by means of a mitre-box (p. 49), the saw should be very fine;

and when it is so the cut will not need planing. But if the saw be coarse, a shooting-block (p. 50) will be required. When cutting and nailing the pieces, they should not be subjected to rough usage, or the gold facing may get splintered at the joinings, which would spoil the frame. It is to be observed that a mitre-box or a shooting-block is better for mitre-cutting picture frames than some mitring machines (p. 49); for these last are likely to fracture the *compo* (p. 152) which can be cut quite safely and smoothly, by means of either of the former.

There is always a length of moulding required for the frame, equal to the whole length all round the *outside;* so that the corner pieces (Fig. 66), are so much waste.

Joining the frame with glue.—The four pieces are joined together sometimes with glue, strengthened with tongues (p. 52); sometimes with nails and glue. Glue and tongues will be sufficient to hold a small frame; but a frame of even moderate size must be nailed.

If glue is to be employed, without nails, the four pieces, *after having been glued*, must be fixed together tightly, and left so till the glue dries. There are several plans for accomplishing this, of which I shall mention two that are very simple and cost nothing.

First plan.—Tie the four together with a strong cord, which is carried tightly along the edge all round by the four corners. Cover the corners with four little angular bits of wood, or cork, or thick cardboard, to protect them from being injured by the cord. When the cord has been tied and knotted, insert four or more little wedges between it and the frame, in the middle of the two sides and the two ends, which will tighten it still farther. Then lay the frame so tied, face up, on a level table, and put four weights on the four corners, to keep it from twisting out of level (put pads of paper under the weights).

Second plan.—Get four pretty strong laths, about

1 inch thick, the same length as the four sides of the frame: these will have to be screwed or nailed down to a board or table so as to enclose the frame. First, place the frame lying on the table—face up—the four pieces lying in their proper positions with the ends together; and screw down the four laths so as to enclose it pretty tightly. Then take up the frame; apply glue at the four mitre joinings, and replace the pieces inside the four laths. Tighten with slender wedges of deal driven down between the frame, and the laths. To prevent injury, better put bits of shaving or cardboard between the wedges and the edge of the frame.

Be sure that the four sides of the frame are kept at right angles, which can be tested by the square, or by any right angle: if they are found oblique, the wedges must be withdrawn and altered. See that the four corners are in close contact with the table underneath, that there may be no twist.

By means of these laths and wedges, the frame may be made as tight as you please.

The glue will dry in a day. After this, the corners can be further secured with glued tongues (p. 52). Nails cannot be driven once the glue is dry, as the boring and hammering would be pretty sure to break the joints.

Jointing the frame with nails.—Read the instructions at page 51 for nailing a mitre joint. First make the hole, almost as deep as the nail. In the first piece, i.e., the piece that is to hold the head, it should be quite as large as the nail, so that there may be no difficulty in driving so far; but in the piece that is to take the point it should be a little smaller, in order that there may be a firm hold: when boring, remember to let the corner of one lie a little beyond the corner of the other (Fig. 29 p. 51). Then apply glue and drive the nail. There is, as already mentioned (p. 51,) a clamp for this purpose; but if one is moderately handy, there is really no difficulty

in driving the nails without any help of the kind—holding the pieces with the left hand down on a table, and using a light spring hammer. The help of a second person may, however, be found useful, especially if the heads of the nails have to be sunk with a punch. If German moulding be used, great care must be taken while nailing not to splinter or ortherwise injure the compo.

Frame makers often use a vice when nailing. They grasp one of the pieces in the vice, catching it by the rabbet and the outside edge, and putting pieces of cloth between the moulding and the jaws of the vice to prevent injury. While the piece is so fixed, the workman bores the hole and nails on the other piece. This is a good plan if one has a vice at hand. A blacksmith's vice will do quite well: but beware of squeezing too tightly.

The glass and backing.—A square of glass to fit into the rabbet is the next thing: for this see p. 147. The glass should be free from flaws or spots, and it must be well cleaned before being placed in position. Put it in its place: it will be well to paste long strips of paper all round the edge, half on the rabbet of the frame, and half on the glass, but not far enough out on the latter to be seen in front. This is to prevent dust getting in from the front. Put the picture on the glass, face down. Down on this again, to cover and protect glass and picture, and keep them in their places, is to be fixed a backing of thin boards, which need not be finely planed or jointed. Sometimes small pictures are backed with cardboard; but cardboard is apt to grow mouldy with the least damp.

The backing must fit inside the rabbet; and it is fastened in with small headless tacks, $\frac{1}{2}$ or $\frac{3}{4}$-inch long, or small battens (p. 62), which can be driven in with a tack hammer, or with the side of a chisel. Care must be taken not to let the tacks press too tightly on the board, or the glass may crack quite unexpectedly during the hammering.

Before finally fastening up, see that all is right; that the picture is in its proper place; that no dust or bits of chip or paper lie between the picture and the glass. If this is not attended to you may have to take the whole thing to pieces after nailing up.

When the backing has been fastened, some strong paper should be pasted on it, so as completely to close up the joining all round at the rabbet, or any cracks or joinings in the boards: this prevents the picture being injured by dust. If the paper is so strong that it is found hard to make the paste catch it, damp it first all over.

Black frames.—Black frames, though not so showy as those made of gilt or German moulding, look extremely well; but they are fit only for pictures with white or light coloured margins. Black moulding may be bought from 1d. a foot upwards.

Any amateur, however, able to use carpenter's tools, can make handsome black moulding and frames for himself. Get an inch thick board of straight grain and free from knots; and cut off from it one or more slits, enough for the entire frame, and of the width required—say two inches. Rabbet one side $\frac{3}{4}$-inch deep (p. 40): this side will be for the back. Put a bead moulding (p. 14) on each edge of the front: B, Fig. 75, shows a section of this frame. If there is no moulding-plane, simply bevel the front of the rabbeted edge; but in this case the rabbet should be only $\frac{1}{2}$-inch deep; A Fig. 75, shows a section of this frame. Lastly, if there is no rabbet plane, the frame may be made without it in this way. Let the slits for the moulding be in the first instance only $\frac{1}{2}$-inch thick; on which nail or glue another $\frac{1}{2}$-inch lath, half an inch narrower, so as to leave a rabbet all along at one side.

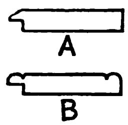


FIG. 67.

Cut and mitre the four pieces, and fix the frame

together, as already directed. When this is done, smooth the front and edges well with sandpaper, and stain it with black ebony stain, sizing and varnishing in the manner shown at pp. 129, 130.

If ebony stain is not at hand, the frame may be stained almost or quite as well with common black ink, in the following way. Wet it plentifully all over with ink; and when this is nearly, but not quite dry, wet it again; and repeat this till the wood is quite black. When the last coat is perfectly dry, rub it well with a woollen rag to polish it. Then apply size and varnish. It is surprising how pretty a framing this makes, when well done; and it costs very little, or nothing at all.

A flat.—It is very usual to put a narrow strip of German moulding all round inside a black or maple frame, say $\frac{1}{2}$-inch wide : this is what is called a *flat*. It can be bought for 1d. or 2d. a foot; and it adds greatly to the appearance of the frame. In this case two distinct frames are made, the smaller one fitting into the rabbet of the larger. The large frame should be made first, and then the small German moulding one to fit into it. This German moulding frame, which has itself a rabbet to hold the picture, is fixed in with little headless tacks, after which the picture is put in as before.

Mounting.—When the picture is an engraving, or a water colour, or a photograph, there is always a white margin left between the picture itself and the frame, varying in width according to taste; but generally speaking the wider the better—within reasonable limits.

If the picture you are about to frame happens to have no margin, or that it is desirable to cut off the old margin on account of being soiled; get a square of white drawing paper, or better, of white or tinted card board, as much larger than the picture as is considered necessary. The picture is to be placed down on this so as to leave a margin all round; and it is to be fastened with paste at the four corners. A

mere touch of paste will be enough—scarcely half the size of a threepenny piece; if a larger surface is pasted, it is apt to wrinkle when drying, which spoils the picture. After touching with paste, lay the picture flat, and put a book down on each corner till the paste is dry. Oil paintings have no margin.

It sometimes improves the look of a framed picture to draw a single heavy line with either black or red ink all round in the margin, ½-an-inch (more or less according to size) outside the edge of the picture.

Be very careful that the picture be not placed obliquely in the frame, and that the margin is of uniform width all round. When the name of the picture is printed at the bottom, this bottom part of the margin is commonly left a little wider than the top—but the difference should be very slight.

Cost.—Suppose a picture 19 by 14 inches (including white margin) has to be framed; and that we choose moulding 2 inches wide, and of a pattern moderately ornamental. This picture will be framed by a regular picture-framer—supplying everything—in gilt moulding, for 11s. 6d., or in German moulding for, 6s. 6d. By giving the dimensions you can buy a German moulding frame, extra quality, ready made; (i.e., merely the four pieces cut and joined), for 5s.; putting in the picture yourself, and providing the glass, which will cost 6d. In this case the framing will cost 5s. 6d. (not counting anything for the thin boarding at the back). But suppose you buy the moulding and do the whole thing yourself; there will be wanted 7½ feet at 6d. per foot, 3s. 9d.; glass 6d.; total, 4s. 3d. The same picture could be framed with black home-made moulding (as described at p. 158), and an inch flat, for about 2s.: or without the flat, merely for the price of the glass, 6d.

Hanging Pictures.

Rings and cord.—Two brass rings, strong enough to support the weight of the picture, are to be screwed

firmly into the frame at the back, from which to suspend it by coloured cord. Both rings and cord can be bought at a hardware shop; and the cord can be got of various thicknesses and of different shades of red and green. There are metallic strings, which, though very thin, are much stronger and safer than those made of hemp or any other vegetable material.

Position of rings.—If the picture is to hang quite up against the wall, the rings may be screwed into the top of the frame. But if the top of the picture is to stand out from the wall, the rings must be screwed in at the back one-fourth or one-third down: in this case they will have to be strong, and must be screwed in very firmly, as they will have to bear more strain than if they are at top. The lower down from the top the rings are, the more will the picture project at top, so that the degree of projection can be regulated by this means. The higher up pictures are hung the more the top should be made project: pictures hung very low may be nearly or altogether parallel to the wall.

Pictures should be hung from brass-headed nails driven into the wall: and it is usual to put these nails as high as the ceiling. Sometimes a brass rod is fastened up at the ceiling all round, from which the pictures are hung, no nails being then used.

Height of pictures.—It may be remarked that pictures are very often hung quite too high: if the lower edge of the frame is 4½ or 5 feet from the floor, the picture is high enough, unless there is some special reason for placing it higher.

Hanging heavy pictures.—It is dangerous to let heavy pictures depend on a single cord; for either the screws may gradually withdraw from the wood, or the cord may break. Some remedy this by letting the lower edge rest on two brass nails driven into the wall; an uncouth plan which injures the wall, and injures the frame.

The following is a simple and safe plan for hanging

heavy pictures. Two distinct cords and two pairs of rings are employed; but only one cord is seen when the picture is hung. Suppose the picture frame to be $3\frac{1}{2}$ feet by 2 feet 9 inches. In Fig. 68, the dotted lines represent the picture frame; and we are supposed to be looking frontwise at the picture, and through it. Two strong rings are screwed in at the back, at A and B, about 6 inches from the top: and two others at C and D, also at the back, and about three inches from the lower edge. These are furnished with two distinct cords, which are thrown over two strong brass-headed nails at E and F.

The two cords must be so adjusted in length, that each will sustain part of the weight; which is known by each cord being strained when the picture hangs freely. The degree of projection of the top is regulated by the respective lengths of the strings. When the string AEB is lengthened, the top is thrown forward; when CFD is lengthened, the top falls back towards the wall.

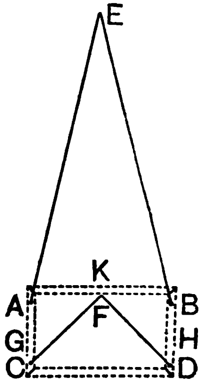


FIG. 68.

For the convenience of adjustment the strings should be at first knotted permanently at one end only—suppose at B and D: at A and C, there should be running knots, which can be loosened in a moment, and the string lengthened or shortened. When the picture is right, knot permanently. Then set the picture perfectly horizontal, which is done by standing in front and grasping one or both sides with both hands, and moving the picture left or right so as to run the strings over the nails E and F. The nail F, and the string CFD are altogether hidden by the picture. It will require two persons to hang a large picture in this manner.

If the picture is extra heavy, the upper cord may be secured in a still better way. The two upper rings may be screwed about half way down, instead of at A and B—suppose at G and H; and two small rings, or two eyelets, such as are used for stair rods, are screwed in at A and B. The ends of the cord are fastened to the rings at G and H, and the cord is passed through the rings at A and B.

The picture rings you buy are sometimes very unreliable; and where there is any doubt of their strength, it may be better to use large stair-rod eyelets all through, which are as safe as common rings.

In all cases where a heavy picture is hung so as to project, a light ring should be screwed into the middle of the top at the back—at K; and opposite it, a small brass nail should be driven into the wall. Then a light strong string should be passed from one to the other and knotted to each, so that the string is just tightly stretched, but not so tight as to draw back the top of the frame to the wall. When this is done the picture under ordinary circumstances is quite immovable and absolutely safe.

CHAPTER XVI.

SOLDERING AND METAL WORK.

Soldering.

Nature and uses of soldering.—Soldering is joining two pieces of metal together by means of another metallic substance called a *solder*, which is melted between them and unites with both, thus causing them to adhere.

It is a matter of surprise how few people are able to solder, considering that it is one of the most useful of household arts; and at the same time inexpensive

and easily learned. A little knowledge and practice will enable any handy person to do most of the soldering jobs for which travelling tinkers are employed. This is often a considerable saving to the housekeeper; for many a good article is thrown aside as useless for want of a little solder: and it is almost always a convenience; for just at the time when the article gets out of order and wants mending the tinker is not to be had.

Solder is commonly understood to be of two kinds, hard and soft. Hard solder will not melt except with very great heat: soft solder will melt at a moderate temperature, as for instance, the heat of iron when it is just beginning to grow red. Hard soldering is usually done with a blow pipe: soft soldering with a soldering iron.

Various soft solders.—Soft solder is a mixture of bismuth, tin, and lead, or of tin and lead alone, which are melted together so as to form an alloy. This alloy has the curious property of melting at a lower heat than any of its ingredients. But although it is so easily melted, it is hard and tough so long as it is not heated to its melting point—or quite hard enough to bind ordinary metals together firmly.

The degree of heat required to melt solder depends on the metals composing it, and on their proportions. If 1 ounce of bismuth, $\frac{1}{2}$ an oz. of tin, and $\frac{1}{2}$ an oz. of lead, be melted together, the alloy will melt below the temperature of boiling water; and there are other compounds still more easily melted. An alloy of this kind is commonly called fusible metal; but it would of course be useless as a solder.

The ordinary soft solder in the shops will melt at about 334° Fahrenheit, and will resist the heat commonly applied to cooking vessels. It is made by melting together 6 parts of tin and 3 or 4 parts of lead. One may make his own solder: but it is not worth while; for soft solder may be bought for the same price—or nearly the same—as the separate

metals. Common soft solder, which can be got in almost any hardware shop, is sold in long rods, and costs 9d. per lb.

Apparatus necessary.—The only things required for soldering are, a soldering iron, some solder, and either a bit of common rosin (or resin), or a little bottle of *killed spirits*. If the killed spirits cannot be got to buy, it may be made in this way. Get at the druggists a pennyworth of spirits of salts (called by chemists hydrochloric or muriatic acid). Dilute it with its own bulk of water or a little less. Drop gradually into this dilute acid some bits of zinc, which will dissolve immediately; and keep dropping in zinc till the acid will dissolve no more. The liquid is then called chloride of zinc, or more commonly killed spirits. It will be better to do this in an open vessel, such as a teacup; and it must be done cautiously, as the mixture gets very hot and gives forth disagreeable fumes.

In addition to the above, any one who works at soldering will have to provide himself with a small shears for cutting sheets of thin metal, which will save a great deal of trouble. A shears about 9 inches long, which will answer most purposes, will cost 1s. 6d.: but a smaller one can be bought for 1s.

Killed spirits: rosin.—Killed spirit is much cleaner to use than rosin, and it may be kept in a phial for any length of time; but if there is any difficulty in getting it, rosin will do quite well. Travelling tinkers always use rosin. We shall for the present suppose killed spirits to be used. The killed spirits or the rosin is what is called a *flux*; for it helps the melted solder to combine with the two metallic surfaces.

Soldering iron.—The soldering *iron* is in reality a piece of copper, fixed into a handle made of iron, except the part held in the hand, which is of wood. The copper bit is round except at the top, where it is brought to a square blunt point. The soldering

iron is commonly called the *iron* for shortness. There are soldering irons of various sizes; but it is best to have a pretty large and heavy one, as a small one cools very quickly, and there is continual trouble in heating it. Where much soldering is done, one ought to have two, a large one for ordinary work, and a small one with a sharp point for narrow corners. A good sized soldering iron will cost 2s 6d.; a small one 1s. 6d.

Toy soldering boxes.—In many shops boxes of soldering materials are sold, containing a little soldering iron, some solder and a bit of rosin. I mention these soldering boxes in order to warn the amateur against them. The soldering iron—the main tool—is quite too small, a mere child's toy: and the rest of the contents of the box are not worth more than about a penny. The whole thing is bright and pretty, but quite worthless for any practical use.

Tinning the soldering iron.—Soldering is done by heating the soldering iron and then applying the point to the solder till it melts it. The iron is then lifted off and brings away clinging to the point, a little bit of melted solder, which is put on the place to be soldered. But unless the copper point of the soldering iron is prepared before-hand, the solder will not stick to it: this preparation is called *tinning*.

In order to tin the iron, put it in the fire; while it is heating, put a bit of solder into a little hollow, like half an egg-shell, scooped in the surface of a brick or soft stone of any kind, and drop on it a little killed spirits, or rub the spirits on it with a feather. When the soldering iron is heated so that it is just beginning to grow red, file the top quickly, while still hot, with a pretty coarse file till about half an inch of the four faces and the extreme point are quite bright. Put the bright hot top on the bit of solder, which will at once melt. Then rub the top in the melted solder, turning the four faces down one after another, rubbing them well, and turning them round and round: do

this quickly, after which lift the soldering iron, and wipe the top with a bit of rag. It will then be seen that a bright metallic coating remains on the surface of the copper; this is a thin film of solder. The soldering iron is then tinned and ready for use.

If, after rubbing the point with a rag, you find there is no coat of solder left, it is a sign that the soldering iron has been heated either too much or too little; and of course the process must be repeated till successful.

Instead of putting a bit of solder into the little hollow at first, it will answer as well to dip the top of the rod of solder into the killed spirits, and melt a bit off it with the hot iron into the hollow: then the iron is rubbed as before.

The tinning will last for a long time if the copper top be not over-heated; but if it be at any time heated too much—for instance, if it is made red-hot—the tinning will be burned off, and the soldering iron will have to be tinned again. Under any circumstances the tinning will wear off after a time, and must then be renewed.

How to Solder.—The soldering iron is used only when the metals to be soldered are in thin sheets, or wires, or other small masses. The reason of this is that both the metals must be heated to the melting point of the solder. This the soldering iron cannot do if they be in large masses.

We shall now suppose that the straight edges of two pieces of tinned ware (or tin as we usually call it) are to be soldered together. This is about the easiest piece of soldering that a beginner can attempt; and anyone able to do it can do most ordinary soldering jobs.

The surfaces that are to be soldered must be made perfectly clean and bright if they are not so already: the best way to do this is to scrape them well with an old knife: or they may be filed, or rubbed with course sand paper, or, still better, with emery paper.

This is more necessary with old tin or tarnished metals of any kind than with new or bright. But even if the tin be new it is better to scrape it slightly. The whole secret of success in soldering may be said to lie in cleaning the surfaces properly: if they are not cleaned in every part failure is certain.

Put the soldering iron in the fire. Place the two plates of tin flat, with the two cleaned edges overlapping about the eighth of an inch, *and in close contact*: and have them held firmly in this position, which may be done with the left hand. Wet the joint all along with killed spirits, using the tip of a feather.

The soldering iron should not be heated red: it is hot enough when it is just on the point of becoming red. The proper degree of heat will be learned after a few trials, for if not hot enough it will not melt the solder: tradesmen know the right heat by putting the iron near the face, and an amateur will soon learn to know it this way too.

When it is hot enough (and after wiping off with a rag any dirt or dust it brings from the fire) hold the point against the end of the rod of solder, till the latter melts; when the iron is then lifted off it will bring away a drop of solder clinging to the point. With the end of the iron put this drop down on the joint at one end (the end to the left), and draw the point of the iron slowly along the joint: it will leave after it a bright thin streak of melted solder, which runs in between the two pieces of tin. When that drop is used up take another, and begin where you left off; and so continue till the whole joint is done. It is a good plan to dip the point of the iron for an instant into the killed spirits just before putting it to the solder to take up a drop: this makes the drop cling better. Whenever the iron grows too cool, it must, of course, be heated.

If, after going over the whole joint this way, bit by bit, it is rough, wet it from end to end with killed spirits, and draw the top of the iron slowly along the

whole length: this will melt the solder again and set the joint smooth.

Tacking.—In soldering a long joint like this, it is often convenient to tack the two pieces together at several points in the first instance, which is the best way of holding them in position. This is done by melting a drop of solder at each of the two ends, and at intervals of two or three inches along the joint (the spots being wetted with killed spirits, and the two pieces being held close). These drops, besides tacking the pieces together, will generally be enough for the whole joint, each drop being run along with the point of the iron till the next is reached. If one is used up too soon, a fresh drop can be brought from the rod.

Quantity of solder needed.—Soldering should be done with the least possible quantity of solder. In a badly done job, the joint is rough with lumps of solder; whereas it should be quite smooth, and the solder should scarcely appear at all outside the joining—except at the very edge. Beginners always commit this fault; but get out of it after a little practice.

Rosin as a flux.—In the preceding job—and all through in soldering powdered rosin may be used instead of killed spirits, both in tinning the iron (should it want tinning) and in soldering. In all cases where it is used it is to be sprinkled pretty thickly along the joint. Many prefer it to killed spirits where a long joint has to be done, as the liquid tends to cool the soldering iron. But rosin has this disadvantage, that it soils the fingers, and after the job is done remains on the work, which therefore has to be cleaned—no easy task where rosin is concerned.

Household Soldering Jobs.—In the manner here described, thin sheets of all ordinary metals may be soldered—brass, copper, iron, lead—any one of them with the same metal or with any one of the others. Zinc may be soldered in the same way, but for this killed spirits must be used—not rosin. It is to be observed

that zinc soon takes the tinning off the iron, and coats it with zinc instead: because copper has a greater affinity for zinc than for tin. In soldering zinc, therefore, you have to tin the soldering iron very often.

To solder old tin.—Sometimes in soldering old worn tin, you find it very hard to make the solder take, no matter how carefully you may clean the surfaces. In obstinate cases of this kind, it is best to tin the surfaces first. Having scraped them bright and rubbed them with emery paper, wet the place with killed spirits (or sprinkle powdered rosin on it), and taking up a drop of solder with the iron, rub it well on the spot till you see a bright coating of solder left on the surface. When both have been prepared in this way, they will take the solder without any further difficulty.

When a tin kettle or saucepan leaks, it is nearly always due to the wearing away of the solder. Observe the spot, clean it well, and having put killed spirits or rosin on it, fill the little hole with a drop of solder.

If the handles of tin vessels get detached, it is equally easy to solder them. If a hole is worn in the tin—either bottom or side—it can be covered with a patch: but here if the tin be old and very much worn, it may be necessary to tin the surface as above described. If it be well cleaned and brightened, however, the tinning will not be necessary: the best of all cleaners for this purpose is emery paper. Scrape well first, and then use the emery paper, which will get into all the little hollows. In certain cases a patch is most easily put on by the process described in next section.

Sweating in.—This is a mode of soldering sometimes very convenient, especially in mending small holes in tinned vessels. Suppose a hole the size of a sixpence in the bottom of a tin kettle. Cut a round piece of tin the size of a half crown: clean this, and

also clean round the hole to the size of the new piece. With the end of a feather wet the cleaned margin all round the hole with killed spirits; and then strew down on this wetted surface small particles of solder, scraped off with a knife. Wet also the piece with killed spirits, and place it down on the hole: it will cover the solder all round.

All this time some piece of metal should have been heating in the fire, and is to be made red hot. Any piece of iron that is broad enough, or nearly so, to cover the piece, will do, such as the top of a thick poker. Put the side of the hot metal down flat on the piece, and hold it there till you find it to descend or float suddenly; the solder is then melted, and the heated metal may be lifted off. Before lifting off, place the top of a knife or any such thing on the patch with the left hand, to hold it down till it is cool: for if left to itself, it is liable to float away from its place after the hot iron is taken off. The soldering is then done.

The soldering iron would be the best heater for this purpose; but the great heat would burn off the tinning, so that it is better to employ something else. A very small quantity of solder will do: if more is used than is wanting it will squeeze out at the edge, and there will be a rough seam all round. To make the matter sure, it may be better in the first instance to tin the edge round the hole, as described in last page.

Soldering with tinfoil.—When two small thin pieces have to be soldered together, it may be done very neatly in the following way. Scrape or file the two surfaces quite clean; besides being perfectly clean, they must fit very accurately. Rub a little wetted sal ammoniac or wetted borax on one of the pieces, on which place a bit of tinfoil, and down on this the other piece to be soldered. Catch the pieces then between a red hot tongs, or hold them (while kept in position) over a clear fire, or over

the flame of a lamp or candle ; in a few moments the tinfoil will melt, and solder the surfaces.

Prices.—The price of tin varies with the thickness. A piece of ordinary tin (such as is used in making common household vessels), 13¼ inches long by 9¾ inches broad, will cost 3d. : sal ammoniac (or chloride of ammonium) is 1d. per oz. : borax 1d. per oz. For emery paper or cloth see p. 178.

Metal Work.

Tools for metal work.—Anyone who works in metals must provide himself with two or three hammers of different sizes, a small anvil, or some smooth-topped mass of iron to answer as an anvil, a good pliers or nippers for cutting wire, a shears, a hand or bench vice, a drill, a small cold chisel, three or four steel punches, a flat mass of lead, a reamer, and files of all shapes, sizes, and degrees of fineness that may be required. (See all these in Index).

Riveting.—If a rivet is to be filed down flush (or level) with the surfaces, the hole must be widened a little (or countersunk: p. 11) at both its openings, otherwise the rivet will have no hold. There is a steel rosebit for this purpose; but it may be done quite as well with an awl sharpened to an obtuse angular point with an old file or on a whetstone; or it may be done with a file if the hole is large.

Materials for rivets.—Rivets of all sizes, iron, brass, and copper—always with heads—are sold ready made. A number of small rivets can be bought for a penny. But it is quite easy to make rivets of any one of the three metals—using hammer, file, and vice: nails or pieces of wire form good materials. There need be no head; but the rivet should be made slightly thicker at one end than at the other, the thick end to represent the head. The middle must be quite as large as the hole, so that the point will go through just far enough, the other end being too thick to permit the rivet to go through altogether. A rivet may indeed

be of uniform thickness, without head; but it is not so easily managed as one of the shape described.

Copper rivets are very easily worked; but they are so soft that if there is any great strain they cannot be depended on. There are little round-shanked, headed, brass tacks sold in hardware shops that make very good small rivets, the head being allowed to remain, and so much of the shank cut off as is necessary. For delicate riveting I have found common pins answer extremely well; but they must be softened in the way mentioned at page 178. The hole for very small rivets of this kind must be of such a size that the rivet will barely go through with a little forcing. If the hole be larger the little rivet will bend obliquely under the hammer, and the work will be a failure.

Rivets countersunk.—We shall first suppose that the hole is countersunk, and that the rivet is to be filed down flush with the surface at each side. When the rivet is through the hole—the two articles to be riveted being held close—it must be filed down at both ends (if it is too long), till it is nearly on a level with the two surfaces: as much of each end being left projecting as will fill up the countersink when hammered. Then holding the two articles, so that the thick end or head of the rivet is down on the anvil (or a common smoothing iron), hammer the small end till both ends are spread out, so as to make the joint tight. The hammer should be a light one, and the blows should be rather light, so as to flatten the ends gradually. If necessary, reverse, and hammer the other end. Then file down the two ends to the common level: the little shoulder filling up the countersink at each end will give sufficient hold.

Rivets not countersunk.—When the hole is countersunk, it will be difficult to remove the rivet, should this ever be necessary. For this reason rivets are put in without countersinking whenever the nature

of the work admits it. Here the hammering will form two shoulders which will spread out on every side around and beyond the hole. These shoulders will keep a hold, and of course the rivet cannot be filed level, but must be allowed to project the thickness of the shoulders at both ends.

Ends of rivet must be flat.—In all cases of riveting the two ends of the rivet (before hammering), must be filed quite flat; and they must be at right angles to the length, or in other words straight across. If either end be filed slanting, the rivet will likely turn aside under the hammer, and spoil the work.

To remove a rivet.—A rivet that is not countersunk can be easily removed by filing off the head at one side—or cutting it off with a cold chisel—and then punching it out from that end, using a small hammer. The article must be placed on some firm support—such as a piece of lead—and there must be a hole to let the rivet down. If the rivet is countersunk it must be filed down as much as possible at one end; and then it may be punched out if the shoulder be not very thick.

To bore holes in metal.—With either of the drills mentioned at page 10, small holes may be readily bored in sheets of iron, or brass of reasonable thickness. The quickness of the work will depend on the sharpness and goodness of the bit. If the work gets on slowly, drop a little oil on the hole. Bits of any size, to fit into the drill, may be bought for 2d. each.

In the absence of a drill, a hole may be bored gradually, merely with the hand, through brass or soft iron, with a common awl, having the point sharpened in the shape of an obtuse angle; this point must be abrupt, not long and fine. It must be sharpened often, for it soon gets blunted. Considerable pressure must be used, and the work is slow and tiresome. In this case also, if oil be dropped on the hole, it will facilitate the work.

A hole may be punched in the following way through an iron plate not more than about $\frac{1}{10}$ of an inch thick, or through a brass plate considerably thicker. Place the plate on a piece of lead resting on some heavy support, or on an anvil with a hole underneath. Drive a sharp pointed punch, or a strong bradawl—using a hammer—till a hollow appears at one side, and a projection at the other. File off the projection: perhaps the hole then appears. If not, repeat the operation till the plate is bored through. The hole can then be enlarged to the desired size with a reamer (p. 11,) or with a bradawl. This mode of boring a hole will throw the plate out of shape, and is not applicable to any delicate article.

To rivet a scissors.—I will now give two illustrations of riveting—a scissors and a spade. The blades of some scissors are fastened together by a screw; those of others by a single rivet, not countersunk but with projecting shoulders. I shall for the present speak of those that are screwed.

In one blade—that which carries the point of the screw—there is a hole with a screw-thread into which the little screw fits tightly: in the other—the blade that carries the head—there is a hole without any screw-thread, large enough to permit the shank of the little screw to run through it freely. From this it will be seen that the screw is fixed firmly in one blade, while the other blade moves round it freely, except so far as it is tightened by the head.

When the scissors is new, the screw-head presses down pretty tightly on the new blade, so as to keep the two blades close together. But after some use the part of the head next the blade gets worn by the constant rubbing, and the scissors becomes loose. When this happens screw it up: but as the thread at the point of the screw may have become rusty, it often requires considerable force to do this. When there is great difficulty, try the effect of wet-

ting the screw with paraffin oil, allowing it to soak in for some time. It will sometimes happen that by no effort can the screw be moved, while the scissors is so loose as to be nearly useless. In this case the screw must be treated as a common rivet, and tightened by hammering, as mentioned at page 27.

The screw of a scissors is hard, and if treated as a rivet, it may break in the hammering; or it may be worn out, and must be removed. In either ease the point must be forced out of the blade with a small punch, or a strong bradawl. The best way to do this is to put the blade down on a piece of lead (as for punching a hole, p. 175); then use the hammer. I have seen the blade of a scissors broken in the endeavour to get out the screw point.

The scissors must now be riveted. Make a rivet of a bit of iron wire: the thick end is to be put in the blade that has the large hole: there is to be no countersinking. Have a projection at both sides sufficient to form moderately thick shoulders; then hammer home and the thing is none. Whenever after this the scissors becomes loose, it is tightened by hammering. The rivet for a scissors must be of iron: brass and copper are too soft.

When a scissors is riveted, the point of the rivet —like the screw—is fixed immovably in one blade, while the other blade moves freely round that part of the shank next the head. If the rivet is worn out it is removed by filing off the projecting part of the top down to the level of the blade, and then punching it out with a punch or a strong awl. A new rivet is put in as described above.

To put a handle in a spade.—The spade here meant is the one that has the handle fixed in by rivets. In this spade there are two iron wings extending upwards from the iron blade for eight or 10 inches at back and front; and below the wings the blade itself is hollow for some distance. The handle is fixed between the wings, to which it is fastened by

two or three large rivets driven through wings and timber; and the end is made to fit into the hollow, through which a rivet is also sometimes driven. The rivets are not countersunk, so that it is comparatively easy to remove them whenever necessary.

When the handle of a spade gets broken a new one must be put in. The handle is generally made of ash. About the making of it I do not think it necessary to say anything, except to remark that a spokeshave (p. 15) is a most useful tool for the final shaping and smoothing.

The first thing to be done is to remove the rivets. Cut off the head at one side with a cold chisel (p. 12), or file it off; and when this is done the other part can be easily punched out. When all the rivets are out, remove the old wood; and if there is any difficulty, burn it out.

If rivets cannot be got to buy, excellent rivets can be made from a bit of paling wire: the new rivets must be fully as thick as the old. Pare the end of the handle so as to fit it into the hollow of the spade; put it into its place and drive it home: then bore one of the holes with a gimlet the full size of the rivet. The rivet must project far enough on both sides to form good-sized shoulders; a pretty heavy hammer will be required; and there must be a solid iron support underneath—the best of course being an anvil. The other rivets are managed in the same way.

Filing and polishing metal.—Read the paragraph about files, page 18.

Where a rough uneven metal surface has to be smoothed and polished, a coarse file is first employed. When this has brought down the surface to a level, a finer one is used; and perhaps after this a finer still. It is then rubbed with rather coarse emery cloth, next with finer; and so on, till the very finest is used, which will leave a high polish on the surface. If emery cloth is used next after a coarse file, it will

polish the surface, but the marks of the file will remain. Emery cloth is sold for 1d. a sheet.

Brass is softer than iron; yet brass requires a sharper file to cut it: a file pretty well worn, that will scarcely bite brass at all, except by great pressure, will file iron fairly well. If one is in the habit of filing both brass and iron, better use new files with brass, and when they are a little worn, use them with iron. The files last longer by this plan. If a new file is used with hard iron, the teeth break off, and the file is soon worn out.

Old worn-out files ought to be kept, as they may turn to many uses. For instance, they will sharpen awls or turnscrews more conveniently and more quickly than a whetstone; they can be used to cut nicks in steel wire that has to be broken off; an old file is the best tool for trying a wall for plugs or wall hooks (p. 85), &c.

Various hints on metals.—Brass is sometimes very hard, elastic, and difficult to bend or work; sometimes it is extremely soft, flexible, and inelastic; and there are various degrees between.

Hard brass may be softened by heating it to a dull or cherry red and plunging it into cold water. Soft brass may be hardened by repeated hammering while cold. If a brass spring has to be made from a soft brass wire or soft brass of any kind, the brass may in this way be made hard and elastic.

Brass may be bought in sheets of various thicknesses. The thickness is denoted by a number: the higher the number the thicker the sheet. No. 1 is as thin as very fine paper; and there is thinner still. No. 3 is about $\frac{1}{80}$ of an inch thick; No. 5, $\frac{1}{67}$ of an inch; No. 8, $\frac{1}{41}$; and so on.

Sheet brass is usually soft, but it may be hardened by hammering. There is a kind of sheet brass which is extremely hard and bright, and so elastic that it is often used for small springs. Ordinary sheet brass is sold for 1s. per lb. The small shears mentioned

at page 165 will cut sheet brass up to number 14 or 15.

Iron is also sold in sheets; and there are several qualities. What is called charcoal iron is very good; it is of English make and corresponds to Swedish iron. Sheet iron is designated by number: the higher the number the thinner the sheet. No. 24 is about $\frac{1}{40}$ of an inch thick; No. 26, $\frac{1}{50}$ of an inch; No. 28, $\frac{1}{65}$ —this last being seldom made and not easily got. The shears mentioned above will cut sheet iron as thick as No. 18 or 16: and it will cut common hoops quite easily.

Iron may be softened by heating it and letting it cool gradually. Any small mass of iron, such as a wire, a nail, &c. may be softened more effectually by plunging it while red hot into dry sawdust. Iron may be hardened by plunging it while red hot into cold water; but this hardens only the surface.

CHAPTER XVII.

GILDING.

Nature of Gilding.—Gilding is simply covering a surface with gold leaf, which is caused to adhere by some sort of glue or size. This is what is called mechanical gilding, which is treated of here: there are other kinds of gilding done by chemical means, but they are usually beyond the reach of the amateur workman.

Gilding is a simple and beautiful art, and easily learned, requiring only some patience, caution, and practice.

Gold leaf.—Gold leaf is so thin (about $\frac{1}{280,000}$ of an inch), that it is blown about by the slightest breath; and on account of this excessive lightness and delicacy an amateur finds it rather hard to manage it. It is sold in pieces 3 inches square: these are kept

between the leaves of a little book, and each book contains 25 gold leaves. In Dublin they charge 1s. 6d. a book for Dublin gold leaf, which they consider the best; but foreign gold leaf is sold for 1s. 3d. a book. There are two shades of colour, both the same price—deep gold and pale gold—the latter containing some silver.

Tools for gilding.—The tools necessary for gilding are very simple, and can be easily made. They are as follows:—*a gilder's cushion*, a *knife*, a *tip* for lifting the gold leaf, and a *bob* for pressing it down.

The cushion.—Take a smooth piece of deal board, 6 inches by 5; and in the centre of one of the two faces fix a little handle 4 inches long to be held in the left hand; or what is more general, a loop of leather for the left thumb. Cover the other side of the board with two or three layers of baize or flannel, which may be fastened with sprigs or carpet tacks all round the edges of the board. Over this is to be placed a piece of shammy (or chamois) leather, or, as it is sometimes called, wash leather, which is also to be fastened at the four edges; it is to be stretched pretty tightly, so that it will be smooth and without creases.

This is the cushion. But some add the following construction, which may be useful, but it is not necessary. At one end, and half way along the two sides, nail three thin bits of wood or cardboard, or a single piece of cardboard or parchment bended round the two angles, and rising about three inches over the shammy, as seen in Fig. 69. The cushion is intended as a rest for the gold leaf; and the raised fence, half way round, is to shelter it from drafts. When a leaf has to be divided it is cut with the knife down on this cushion.

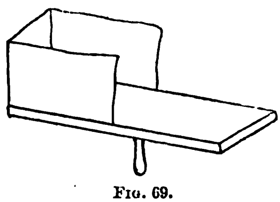


FIG. 69.

The shammy must be carefully kept from dirt or stain, especially from grease or oil: even the hands of the operator, though perfectly clean, ought not to touch the surface.

The knife.—A gilder's knife (Fig. 70), costs 1s But any ordinary long knife will do by a little preparation. It should be as nearly as possible the shape shown in the figure, having a long straight edge, and a sharp angular point. The top of any old knife can be worn down to this shape, or broken across and ground smooth. The edge must not be like the cutting edge of a common knife, which is sharp, and has minute teeth like a saw. The knife used in gilding must have rather a blunt edge, which must be quite smooth, without teeth or gaps: if it were sharp it would cut the cushion as well as the gold leaf. In preparing the knife, the edge may be slightly blunted and made smooth by rubbing on a common slate or on an oil stone, with a little oil. I have used a common kitchen knife prepared in this way and found it to answer quite well.

FIG. 70.

The knife-handle and blade must be kept scrupulously clean, and the blade bright: the final cleaning touch, when you are about to work, is best given by drawing the blade several times between the leaves of a clean book, or through shammy pressed against the sides. After this, do not let the blade touch anything—not even the fingers. Grease or oil of any kind is the great enemy: the slightest trace of it will give trouble or spoil the work.

The tip.—This is a broad thin brush, usually made of squirrel's hair. A tip that will answer very well can be easily made. Get two bits of card, each about two inches square; and cut them into any convenient shape, such as that in Fig. 80: get also a pretty large camel-hair brush (2d.), and take out the hairs.

The two cards are to be glued together (using as little glue as possible), so as to catch the thick ends of the hairs, spread out along the edge; the hairs projecting, so that when the glue is dry, the whole will form a little brush, as in the figure.

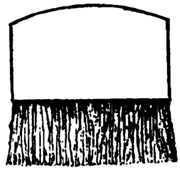


FIG. 71.

The bob.—This is a sort of soft ball, made in the manner shown in Fig. 72, by wrapping a piece of shammy round cotton wool, and tying it. The round smooth part is used for pressing down the gold leaf, while the tied part is held in the hand. Any very soft substance, such as a loose bit of cotton wool, or a thick camel-hair brush, will answer for this purpose.

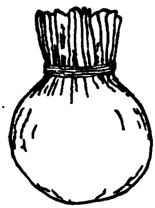


FIG. 72.

Cleanliness necessary.—Before proceeding farther, it may be well to warn the amateur again that in every part of the process of gilding, perfect cleanliness is essential, not only of the hands, but of all the tools and materials employed.

Two kinds of mechanical gilding.—Mechanical gilding is commonly considered to be of two kinds, *dead* gilding, and *bright* or *burnished* gilding. In the former the gold leaf is caused to adhere by an oil size, and hence it is often called *oil gilding*; in the latter the leaf is made to adhere by a water size, whence it is commonly called *water gilding*.

Oil or dead gilding.

Smoothing: stopping or grounding.—We shall first describe the method of gilding new wood, as it is a good type of the sort of articles that are often gilt by this process. The surface must be made in the first instance quite smooth by being rubbed with sand paper—coarse first, finer next, and very smooth last (sand paper is ½d a sheet). After this,

it should be polished with shammy or flannel. The smoother the wood and the higher the polish, the more brilliant will be the gilding.

Next, the pores must be stopped so as to make the surface non-absorbent. This is what is called *stopping* or *grounding*: workmen call it *satisfying*.

Boiled linseed oil (p. 115), either alone or mixed with a little white lead, makes an excellent stopping; but it takes long—generally a day—to dry. Two or three—perhaps four—coats will be necessary, according to the absorbing power of the wood; and each coat must be quite dry before the next is laid on. Should this grounding grow two thick for working, it may be thinned with turpentine.

Japanner's gold size (see below), is a much more convenient stopping, because it dries in an hour or so. It may be laid on with a camel-hair brush, and two coats will generally be enough; but if not, a third or a fourth may be laid on. When the pores are filled there will be a slight gloss on the surface. Each coat, when dry, should be smoothed with very fine sand paper.

Japanner's and oil gold size.—The surface to be gilt, having been stopped, must be *sized* to make the leaf stick on. There are two kinds of size for this purpose, *japanner's gold size* and *oil gold size*. The former dries in about an hour, which is a great convenience: it may be bought in an oil and colour shop, or at a druggist's, for 1s. 9d. per pint. The oil gold size (which costs 3s. 6d. per lb.) takes more time to dry, but it is by far the best, especially where the gilding is exposed to the weather. Indeed japanner's gold size will not answer for open air gilding at all, for it will not stand the weather.

Oil gold size should be of such a consistency that it will work freely. As it is bought in the shops it is generally two thick for use: and it may be thinned with either turpentine or boiled linseed oil. It should be of the consistency of thin paint.

To make oil gold size.—If there is any difficulty in getting oil gold size, it may be made by boiling ½ a pint of common raw linseed oil (p. 115) in which ½ an oz. of litharge (4d. per lb.) has been mixed. Once it comes to a boil it may be taken off the fire. When cold it is somewhat like thick gum, and may be kept for use in a bottle. This boiling is, however a very disagreeable job; for the smell is abominable, and the vessel cannot be used for anything else for a long time after.

Oil gold size with ochre.—It is often of advantage to mix with oil gold size a little yellow or red ochre (2d. per lb.), very finely powdered: as much ochre is to be used as will give it a decidedly red or yellow tinge, so that when laid on with a brush it will look like very pale paint. This mixing can be done each time as it is wanted, a little of the size being poured out on the back of a plate, and the ochre mixed in with a knife or a smooth splinter of wood. The use of the ochre is to enable you to see exactly where you lay the size when you are gold-sizing designs about to be gilt. If the amateur does not wish to trouble himself with this mixing, he may buy the oil gold size ready mixed with the ochre; and this size may be used for all oil gilding. It is indeed an advantage to have a yellowish or reddish ground under the gold leaf, as it gives it a richer colour.

Although it is better to use oil gold size for general gilding, it will be well to keep some japanner's gold size also, for various purposes. It is very useful, for instance, in mending faults in old gilding: and as it dries so quickly, a little job of that kind can be finished off at once.

Laying on the gold size.—When the surface of the wood has been stopped, the gold size is laid on with a camel-hair brush. It must be laid thin, else it will run into streaks, which will show on the gilding: the thinner it is the better, provided every spot has been covered. The greatest care must be taken to

spread it evenly—not heavier in one place than in another.

The size must be let dry till it feels *just a little sticky*: to catch it at the right consistency is the most important point of all. It must be *nearly* dry. If it be so wet that it will daub the finger, the gilding will be dull: if it be too dry and hard, the gold leaf will not stick. If by accident it has been let grow too hard, warm it before a fire, which will soften it. Then lay on the gold leaf before the size has time to cool. If this fails the surface must be sized again. The oil gold size takes from 12 to 36 hours to dry—very much according to the weather. If it be spread unequally it will dry unequally, so that it will be dry in some places while it remains wet in others, and the work will be spoiled.

Transferring the gold leaf to the cushion.—The next part of the work is usually considered the hardest for an amateur—getting the gold leaf first on to the cushion and then to the surface. Here it may be as well to remark that this work must be carried on in a room quite free from draughts. And it will make the gold leaf more manageable if the little book be placed before a fire for half an hour to remove all damp.

Sometimes whole leaves are laid on the surface; but more generally the leaf is cut, and laid on piece by piece. We shall for the present suppose that it is to be cut. In this case the cushion is used, for it is not usual—nor is it easy—to cut the gold leaf down on the page of the book The square is transferred from the book to the cushion by turning the open page with the leaf on it quickly and dexterously down on the shammy. Another way is to slip the knife under the leaf on the page, and lift it on to the cushion. Tradesmen blow the leaves with the breath from the one to the other.

When the leaf has been laid on the cushion, if it be crumpled, spread it out evenly with the knife, by

working the top of the blade under it. Another way to take out the crumples: hold the leaf down at one edge with the knife, and level it by blowing on it gently with the breath. Gilders level it out by gently blowing on it, and nothing more; and a mere amateur, after a little practice, will easily learn to do the same.

Cutting the gold leaf.—Now cut it with the knife edge into the required sizes, pressing the edge gently down on it, and working the knife with a short even backward and forward motion like a saw. A gilder will divide it in a moment with one decisive cut. If the knife be not perfectly clean and bright, or if the edge be rough, or if there be the smallest trace of greasiness—such for instance as might be given by a touch of the finger—the blade will tear the leaf, and when lifted, will bring it away. But if it be in good order, strips $\frac{1}{16}$ of an inch wide, or bits $\frac{1}{4}$ of an inch square, may be cut with it.

Laying on the gold leaf.—The pieces of gold leaf are lifted from the cushion and brought to the sized surface with the hairs of the tip, which must be made very slightly oily, that the gold leaf may stick to it. The usual way to do this is to rub the edge of the tip on the hair of the head, which is generally a little oily. But if the hair be dry, a bit of oiled paper with the oil nearly dried will answer. Sometimes merely breathing on the tip will make it sufficiently sticky to take up the leaf; or try rubbing it on the cheek or forehead.

Having oiled the tip, lay the hair edge along the edge of the slip of gold leaf, which will stick to the hair and come away with it. Lift it off, and lay it down in the proper place on the surface, where it will stick to the size. Stick on bit by bit in the same way, making each bit slightly overlap the preceding one to avoid gaps or faults; and so proceed till the whole surface is covered, or as much of it as is to be done at the time.

Then take the bob or the camel-hair brush and press it repeatedly on the gold, going over the whole surface, to bring it into close contact and make it adhere. After which brush it over very lightly with a soft camel-hair brush or with a bit of loose cotton wool, to remove all the loose bits of gold leaf. The same bit of cotton wool held in the left hand often serves for both bob and brush: when one bit becomes soiled, throw it away and take a clean bit. If any gaps or cracks appear they can be filled up with the fragments that have been brushed off: the bits can be taken up and laid on with the point of the knife (or with the point of a penknife wetted on the tongue), and pressed down with the bob. Finish off by smoothing lightly with a piece of soft shammy. The surface is then gilt, and there is no appearance of seams at the joinings. It may lastly be brushed over with very thin size (one part ordinary size to two of water), which will give it a richer appearance and help to preserve it.

The gilt article must be let lie by for a few days to allow the size to dry completely and the gilding to harden.

The gilding done with oil gold size as described above, will bear washing with water without coming off or any other injury: but the washing should be done very lightly and carefully with a soft brush.

Waxed Paper as a tip.—There is another plan by which the gold leaf may be brought direct from the book to the surface without using either cushion or tip: this is done with *waxed paper*.

Take a piece of clean white paper, somewhat larger than the gold leaf, and rub its surface all over with a bit of white wax—the ordinary white wax you buy at the druggist's: one pennyworth will last for any length of time. A bit of a good wax candle will answer almost as well as pure white wax. Beeswax will not do: it is too sticky. The wax must be rubbed on very evenly and without streaks: rub it first one

way, then across, then obliquely, till the coat is quite uniform. This will take up the gold leaf and part with it to the size.

Press the waxed paper gently down on the gold leaf in the book—passing the finger over every part; take it up, and it will bring away the whole square, or whatever part of it may be wanted. Apply the leaf to the sized surface, and rub the paper lightly on the back to bring the gold into close contact with the size. Then remove the paper: the gold will remain on that part of the surface that has been sized, and all the rest of the gold will come away with the paper. Apply the gold remaining on the paper to another part of the sized surface; and so on till the whole of the leaf is used up.

Sometimes tissue paper is used for this purpose; it has the advantage of being semi-transparent, and you can see through it the bits of gold leaf that are left on it.

I have gilt repeatedly in this way, and find it a most convenient plan. If it is well managed there will be very little waste; and you avoid the trouble of cushion, knife, and tip. It will answer in a great many cases: but it will be necessary to have the cushion, knife, and tip at hand, for they must be used in gilding some things.

Gilding in the open air.—It is well to remark that in open air gilding, as when tradesmen are gilding the letters and decorations in front of a shop, the gold leaf is put direct from the book to the sized surface—no cushion or tip being used. The workman first separates the 25 leaves of the book—each leaf carrying its own gold leaf—and puts them in a little box lying at his hand. Taking out a leaf, he presses the gold side on the size, which retains a part of the gold. Then he applies what is left of the square to another part, and so on, till the whole square is used up, when another leaf is taken out. All the time he holds in his left hand a bit of loose cotton wool,

with which he presses and brushes as he goes along. This is about the simplest of all ways of gilding; and you often see tradesmen working in this manner on breezy days, when the use of cushion or tip would be out of the question. This method is however always attended with waste.

Gilding painted or polished wood.—Sometimes wood is painted before being gilt: if so the last coat should be flat (pp. 116, 122): and when thoroughly dry and hard it should be rubbed quite smooth with the finest sand paper. No stopping will be needed, for the paint is itself a stopping. Then apply the oil gold size in the usual way. The last paint coat before gilding is commonly white: but if it be red or yellow it will make the gilding look richer.

If old painted or French-polished wood is to be gilt, the only preparation required is to smooth it perfectly with sand paper—coarse first, and afterwards fine: no stopping. When a metal, such as iron, zinc, &c., is to be gilt, it is usual to paint it in the first instance: when the paint has dried, and has been well smoothed, it is sized and gilt in the usual way.

In the manner above described, any smooth surface may be gilt, whether it be wood, metal (painted or not), china, marble, plaster of Paris, &c. But it must be always borne in mind that if the substance in hand be absorbent it will require stopping. Most kinds of stone are easily satisfied or stopped. But plaster of Paris is very absorbent and it is hard to satisfy it. The usual grounding for it is thick shellac varnish (1s. 6d. a pint): coat after coat is to be laid on till the surface is perfectly stopped, which is known by the varnish drying at last with a slight gloss; but any common varnish will answer very well. Or it may be stopped by three or four successive coats of boiled linseed oil—each coat taking a day to dry: after these a coating of japanner's gold size: then the oil gold size and gold leaf.

Gilding a long band.—If a whole surface is to be

gilt, the preceding instructions apply, and the process is comparatively easy. Neither is there any difficulty in gilding such a space as a long band. Suppose a band $\frac{1}{4}$ or $\frac{1}{8}$ of an inch wide is to be gilt, the oil gold size—ochred (p. 184)—is laid on carefully along the band with a fine camel-hair brush. Then the gold leaf is cut into strips slightly wider than the band, and when the size is in right condition, laid along in the proper place: the excess will brush off in the usual way, and the gilt band will remain.

Gilding a design.—But the process becomes more difficult if a design, such as flowers, animals, letters, or geometrical figures, have to appear in gold. Here it would be impossible to follow each minute part with gold leaf. The design must be painted with ochred oil gold size: and if the pattern be complicated this is the part of the work that requires most care, patience, and steadiness of hand. Here also will appear the great use of having the size ochred: for every touch of the brush shows, as if you were executing a painting. Then, after the proper interval, the leaf is laid on over the whole design, and pressed down with the bob. It will stick only to the parts sized: and when brushed over in the usual way with a camel-hair brush or with cotton wool, the design will come out in gold. The intermediate parts, if not painted already, may be then painted in colours according to the taste of the artificer.

To make a surface non-adhesive.—When letters or designs of any kind have to be gilt on a surface soon after painting, it may happen that the general surface, not having quite time enough to dry, remains slightly sticky. In this case the gold leaf would stick where not wanted as well as to the gold size; and there would be much trouble in getting it off, as well as waste. This is prevented in the following way. Before painting the design or the letters with gold size, dust or *pounce* the whole surface with fine whiting, in the following manner:—Tie up the

whiting tightly in a little bag of linen or calico, and tap the surface all over with it: it will leave a thin coating of whiting adhering to the paint, which will prevent the gold leaf from sticking to it. Then paint in the design: the ochred size will quite remove the whiting dust as you go along. After gilding, the whiting can be removed from the rest of the surface by merely touching it all over with a moist rag.

To gild carved or uneven surfaces.—If, instead of being flat or smooth, the surface to be gilt contains carved work, the bob will not press the gold leaf into the angles and small depressions. But this may be done with a camel-hair brush, which is sold for this purpose and costs 1s.: or equally well with a bit of cotton wool. In this work breaks will often occur in the leaf which had best be filled up as you go along. It is of course more troublesome to gild an uneven surface than an even one.

Timber picture frames may be oil gilt in the manner described above: for instance the home-made frame described at page 158 might be gilt in this way, instead of being stained black. But it is more usual to water gild picture frames, for which see page 192.

Gilding on cardboard or paper.—Cardboard or paper may be gilt like wood, but it must be first protected by common size, exactly in the same way, and for the same reason, that a map is sized before varnishing (p. 133). There is a size sold for this purpose in the oil and colour shops; but the size used for maps, which one may make for himself, as shown in the page referred to, will answer quite well. This size may be made so strong that one or two coatings will be sufficient. Before laying on the oil gold size, trial should be made on a waste bit of cardboard, to ascertain if the surface is sufficiently protected.

Beautiful designs may be produced by gilding on cardboard. Either the design is gilt and the back-ground painted in water colours: or the back-ground

is gilt and the design painted. For all such work as this, the oiled gold size must be ochred.

Gilding on silks and other fabrics.—Designs may be gilt on silk, linen, or indeed on any thin fabric in the same way. Here the protecting size should be thicker than for cardboard or paper. Lay on coat after coat till the surface appears sufficiently sized. Then paint the design with ochred oil gold size, and lay on the gold leaf in the usual way.

To write in gold on paper.—Mix gum with ink—say half and half—and write with this on the paper. When the writing is dry, breathe on it, which will make it a little sticky: then put the gold leaf on the part breathed on, and press it down with the bob or with loose cotton wool. Brush it lightly with a camel-hair brush, or with the cotton wool, which will remove the gold leaf from all parts of the surface except the writing.

Another way: mix up some whiting with strong size or gum; and with this, draw letters or any design on the paper with a camel-hair brush. When the writing or design is nearly dry, apply the gold leaf in the usual way; after which brush off the superfluous leaf.

Bright gilding: matt gilding.

Two kinds of bright gilding.—Bright gilding is produced either by laying the gold leaf on a burnished surface, such as glass, china, &c., or by laying it on an unburnished surface, and then burnishing it with a tool. We will first consider this latter method.

Coating a frame with Compo.—Let us suppose that a picture frame is to be gilt. The bare wood may be oil gilt in the usual way without any coating intervening between the gold and the wood, except of course the necessary coatings of size. But if any part of it is to be bright gilt, it must be all covered with a coating of *compo* in the following way.

The surface must first be made quite smooth with

sand paper. It then gets a coating of *thin white*, i.e. *parchment size* (8d. per lb.) mixed with a small quantity of whiting—not much more than enough to colour it. This thin white fills up the pores of the wood. The whiting used here, and all through this gilding process, must be of the very finest kind.

After this it receives 6 or 8 coats of *thick white*, which is made by mixing whiting with parchment size till it is a little thicker than common paint. Each coat must be dry before the next is laid on. By this process the wood is thickly coated with white composition or *compo*. Frames ready prepared in this way may be bought (p. 195): they are commonly known as *frames in white*.

The surface must next be smoothed with fine sand-paper. If there be a carved or finely moulded pattern, the angles—if they have been blunted or choked up—must be made sharp, using penknife, sandpaper, or pumice stone, as occasion requires. Lastly, the parts intended to be burnished should be polished with a linen rag moistened with water. The frame is then ready for gilding.

To gild a "frame in white."—Oil or dead gilding cannot be burnished; but water gilding can. Before water gilding is burnished, it is dead like oil gilding, from which it can then be hardly distinguished. Water gilding not burnished is called *matt*.

Sometimes the three kinds of gilding—oil, matt, and burnished—are mixed on the same frame. The very small carvings are oil gilt, as being the easiest kind of gilding (but they might be matt gilt): the large flat surfaces are gilt matt; and the small bead mouldings, the prominent parts of beads or other plain ornaments, flowers, &c., are burnished. As to the parts to be burnished, this very much depends on the taste of the workman. If no part is to be burnished, then the whole frame may be either matt or oil gilt.

Burnish gold size.—For any part that is to be

oil gilt, oil gold size is of course employed (p. 183): but in all the other parts of the frame the gold leaf is made to adhere by what is called *burnish gold size* (1s. 6d. per lb.). This size, as it is bought, is commonly two thick for use—something like soft butter: and it must be thinned with *parchment size*, till it is like paint. But one may buy it ready thinned by asking for *mixed burnish gold size*: in its thick state it is *unmixed*. Apply three or four coats of this size; one coat to be dry before the next is laid on. When the last coat is dry, the parts intended to be burnished ought to be rubbed smooth with a linen rag: or if thought necessary with very fine sand paper first, and then with the rag.

To lay on the gold leaf.—Place the frame in a slightly slanting position; begin the gilding on the top and work downwards. Wet a small part with a camel-hair brush—keeping a mug of water at hand for the purpose—and while the spot is still wet lay on a bit of gold leaf with the tip. It will immediately adhere. Wet another spot, next below the gilt part, and lay on the leaf: and so on. Each bit of gold leaf should overlap the preceding by $\frac{1}{8}$ of an inch. Be very careful not to let water drop or run on the gold leaf already laid on, which would stain it: but of course the narrow edge that is to be over-lapped must be wetted with the brush. Proceed in this way till the whole is covered, pressing the gold leaf into the hollows with a brush or with cotton wool. Cracks or faults of any kind in the leaf should be mended as you go along, for after the work is finished it is not easy to do this without injury.

Matt and burnish.—The gilding, as it stands now, is called *matt*, i.e., unburnished water gilding: it has about the same degree of brightness as oil gilding.

It is usual to burnish the plain mouldings and the plain parts of ornaments of a picture frame, leaving small carvings and designs matt; and this mixture of

matt and burnish, gives it a very rich appearance. The burnishing is done before the size has time to dry completely: it will be ready for it in about 24 hours after laying on the leaf. An agate burnisher may be bought for 1s. 9d.; but a dog's tooth, which was the tool used by the gilders of the olden time, will answer equally well. Rub the gold gently backwards and forwards with the side of the tooth or burnisher, which will very soon bring out the full burnish.

This is the sort of gilding commonly put on looking glass and picture frames. It is fit only for indoor work, for wet of any kind will stain it, and of course it will not bear washing.

Gilders have commonly two different kinds of size for matt and burnish gilding: for the former what is called *matt gold size*; for the latter, burnish gold size, the same as described above (p. 193). But an amateur may content himself with burnish gold size alone, which will answer very well for both matt and burnish gilding.

Mouldings in white.—Picture frame moulding covered with compo ready for gilding can be bought in all shops where picture framing is sold.

A moulding of this kind 2 inches wide, with an ornamental pattern, will cost 6d. a foot. The same moulding gilt will cost from 1s. 9d. to 2s. a foot. (Compare these with the prices of German moulding, p. 153). When a frame has been cut from this moulding, and jointed together, nothing more is required—after the necessary smoothing—but the application of the size and gold leaf, and the subsequent burnishing.

Re-gilding.—Tarnished or faded oil gilding may be renewed without any trouble; nothing to do but first clean it and then oil gild it in the ordinary way.

To re-gild tarnished water gilding. Wash the matt parts well with a cloth and water, or soap and water followed by pure water. The burnished parts

must be rubbed hard with a wet cloth till the gold is all removed: after which polish with a linen rag as for new gilding (p. 193). Then when the frame is quite dry, give 4 coats of burnish gold size to both burnish and matt parts, Polish the parts to be burnished as for new gilding (p. 194): after which apply the gold leaf over all as shown at p. 194; and burnish the parts intended to be burnished.

When water gilding becomes tarnished it may be oil gilt (having been first well washed); but if this is done, there can be no burnishing.

Gilding on glass.—When gold leaf is laid on glass it does not require burnishing: the mere laying on is sufficient, for contact with the smooth surface gives the gold a burnish. It must be borne in mind that glass is gilt on the back, the gilding being seen through from the front.

Any small design may be gilt on glass in the following way. First of all the glass must be made absolutely clean with whiting: the whiting may be rubbed off with a bit of dry silk or with dry clean cotton wool. Cover the whole surface of the glass with gold leaf, which is made to adhere by a very weak size. This size—which should be little more than water—may be made by dissolving a few drops of common gum—scarce half a teaspoonful—or a pinch of isinglass, in half a teacupful of hot water. Indeed the leaf would stick to the glass by merely wetting with the tongue: but the gum water is better. Press the leaf firmly down with cotton wool; and fill up breaks in the gold before proceeding farther. The gold leaf and size may be dried before a fire—not too near or too hot. When it is dry, brush it over lightly with dry cotton wool: this will make the burnish still brighter.

Now, using Brunswick black and a camel-hair brush, paint the design on the gold leaf; and remember that whatever you draw will appear reversed when seen frontwise—if it have a reverse (like

letters). When the Brunswick black is dry, it will protect the design and hold it firmly fixed to the glass; and the gold leaf may be brushed off from the rest of the glass with cotton wool moistened with water.

In part or all of the vacant space, silver leaf may be laid on and fixed in the very same way. When the silver leaf has been removed from those places where it is not wanted, the *whole* of the back may be painted in water colour, which will appear in front only through the vacant spaces.

During the whole of this painting process the glass lies flat on a table, and the hand must not be allowed to touch it. To guard against all danger of this, it is usual to have a rest of some kind for the right hand, such as a narrow lath resting on two books, one on each side.

In this manner, by a proper disposition of the two kinds of gold leaf, deep and pale, with silver leaf and bright colours, beautiful designs may be executed on a piece of glass.

Silver leaf and Dutch metal.—Silver is beaten out into leaves like gold, which are also used to cover surfaces; but as it is not near so thin or so light as gold leaf it is much more easily managed. It is sold in books, each containing 48 leaves, 4½ inches square: a book costs 9d.

There is also an imitation of gold leaf, called Dutch metal, which is merely copper leaf coloured to resemble gold. Its chief recommendation is its cheapness, for it costs only 2d. per book.

Both silver leaf and Dutch metal are laid on in the same manner as gold leaf; but the oil gold size must not be allowed to grow so dry: it must be more sticky for silver leaf than for gold leaf, and still more sticky for Dutch metal.

Silver leaf is very beautiful when laid on well; but it must be protected by a varnish—hard oak varnish will answer—else it will tarnish after some time.

Dutch metal must also be varnished: if not it will lose all its bright colour in a week or two, and will ultimately turn a dirty black. It is often used—varnished—for temporary ornamentation; and for the time, looks almost as well as gold. Even when varnished, however, it will not last long; and the less the amateur has to do with it the better.

CHAPTER XVIII.

FILTERS AND HOW TO MAKE THEM.

Various impurities of water.—Water may be impure in three different ways: first, it may contain particles of matter floating mechanically, as mud, dust, small insects, &c.: secondly, it may contain organic, *i.e.* animal or vegetable matter: and thirdly, it may contain mineral substances dissolved, or, as we say, held in solution, as salt, lime, sulphur, iron, &c.

It is difficult or impossible to remove mineral substances held in solution. But in every-day life this is of no consequence; for though the water derived from ordinary sources—springs, rivers, rain, &c.—always holds dissolved in it many mineral substances, hardly any of them are injurious—except they are in great excess—and some are beneficial. So in speaking of filters we shall neglect mineral substances altogether.

Particles of any substance floating mechanically in water, so as to be seen by the naked eye, may be either injurious or harmless: but in all cases they are offensive in water that is used either for drinking or for cooking; and it is therefore desirable or necessary to remove them.

Danger of animal matter in water.—Of all the impurities that find their way into water, the worst

by far is decaying animal matter. If the water supply, whether spring well, pump, or stream, be very near a dwelling house, a stable, a privy, a cesspool, or a graveyard, it is sure to be impure; for the foul animal matters find their way into it through the ground.

Such water is dangerous and treacherous—all the more so inasmuch as it may be bright, and sparkling, and particularly pleasant to the taste; while in reality it is deadly poisonous, and may give diarrhœa, English cholera, typhoid fever, &c., to those who drink it; or it will propagate any prevailing epidemic, such as Asiatic cholera. Moreover, it not unfrequently happens that the people of a village or town drink the water of a well for a long time without any general evil result so far as can be perceived; but suddenly an epidemic of typhoid fever breaks out and desolates the place:—all the work of poisonous water.

Use of filters.—The object of filtering is to remove floating particles and decaying animal matter; and water intended for drinking in any shape should be filtered, if there is the least reason to believe that it is contaminated.

Various filtering materials.—With regard to floating particles: as they float mechanically they may be removed mechanically, by passing the water through a very fine strainer. There are many substances of which such a strainer may be made, such as blotting paper, sponge, fine muslin, unglazed earthenware, or best of all, sand. When the water is passed through one of these, the floating particles are held back, while the water passes through.

Sand will hold back a portion of the organic matter also, but only a small portion; the rest will pass through, and the water will consequently retain all its poisonous qualities. To remedy this, charcoal is used along with sand. Charcoal acts in two distinct ways. First, it forms, like sand, a mechanical filter

or strainer, though not a good one. Secondly, it acts in quite a wonderful way on decaying animal and vegetable substances, absorbing the poison and rendering it harmless.

How to filter water.—It is then a perfectly easy matter to filter water:—Cause it to flow through a layer of sand and a layer of charcoal—both of sufficient thickness—and the thing is done. The water that comes through these two layers is freed from substances floating in it, and also from organic matter. The sand and charcoal are always placed in an earthenware vessel, with a hole to let the water through. This vessel and its contents constitute a filter.

To make a filter.

A filter easily made.—Detailed directions will now be given how to make a filter: it is an extremely simple matter—so simple indeed that anyone who only wishes to try his hand can make one. We shall suppose that only common and cheap materials are at hand: no one need be discouraged by this; for with such homely materials, a filter may be made as good as those you buy, and in many respects better than some.

The filtering vessel.—The size of the vessel will depend on the circumstances of the case: but it should hold at least three quarts after the materials have been placed in it: for a family it should hold a gallon and a half or two gallons.

A large flower pot of the better kind is as good as the most expensive vessel: one 12 inches deep, 12 inches wide at top and 8 inches wide at bottom will hold about a gallon and a half when the filtering materials have been placed in it, and will cost about 1s. 3d. Before being used, this should be let stand some time filled with hot water, and afterwards well cleaned inside and outside. Any earthenware vessel, such as a common pitcher or crock, will also answer; but it ought not to have a narrow mouth, as in this

case it would be impossible to get in the slate (mentioned in next page). If a pitcher be used, a hole ¼ of an inch in diameter or less must be bored in the centre of the bottom for the filtered water to pass through.

The charcoal.—There are two kinds of charcoal, wood and animal, the former made from vegetable substances, the latter chiefly from bones. Animal charcoal is best, for it acts far more energetically than the other; but wood charcoal will answer very well if animal charcoal cannot be got. In some of the best filters the two are mixed. Both are sold in druggists' shops: animal charcoal costs from 6d. to 1s. per lb.; wood charcoal 2d. per lb.

One lb. of charcoal will be enough for a small filter: 2lb. for a large one. It is sold in lumps, or in grains (granular), or in dust. The granular is the form for a filter. If it is bought in lumps, the lumps should be broken up till it is in grains, something like blasting powder or coarse salt; and the mere dust and very small particles should be removed by sifting.

It is first to be put into a vessel of some kind, and heated on a good turf or coal fire till it is red hot—which will take near an hour; once it has become red it may be taken from the fire and let cool. A crucible is of course the best vessel to heat it in, if it can be got: if not, a small iron pot, or a good sized piece of tin—old or new—rolled up into a hollow cone as they roll small grocery papers. I have seen it heated in a common flower pot with the hole filled up with clay; though this is liable to crack on the fire. Or a piece of old tin may be turned up at the sides all round, till it forms a sort of little pan, in which the charcoal may be heated—small portions at a time—by placing it for a sufficient time on the top of a clear fire.

The use of this heating is to expel the gases which the charcoal has condensed in its pores: but some would not consider it necessary at all.

After the charcoal has been heated—or whether heated or not—it must be washed in clean water to remove the dust particles, which might give the water a slight flavour of soot.

The sand—The sand must be just fine enough to let the water trickle through: if it be too fine, it will stop the flow nearly or altogether. It should therefore be sifted to remove the very small dust-like particles. It must then be washed several times, till the water comes clear from it; After which it should be boiled in water two or three times (the water being changed each time) to remove any injurious soluble matter.

To place the sand and charcoal.—Put a piece of slate or a flat stone on the bottom of the vessel, to cover the hole, but so that it will let the water pass through all round. On this put some small pebbles or coarse sand, and on this the ordinary sand—the sand to form a layer about 1½ inch thick. Down on this the charcoal—two inches thick. Try now before going any farther whether water will flow through.

Next, two inches of sand; and test with water again. The water should now flow through so as to fill a gallon measure *in about* 45 *minutes*. If it flows too slowly, the sand or charcoal, or both, are too fine, and the filter may not give water as fast as it is wanted: if the water flows too quickly, the materials are too coarse, and there is not sufficient time for effectual filtering.

The chief use of the under layer of sand is to prevent the water from bringing with it any particles of charcoal, which, though not injurious, would give the water a sooty taste.

To fix the sand.—But the sand must in some way be made firm on the top; otherwise the water, as it is poured in, will loosen and displace it. This may be done by placing down on it a piece of thin slate, chipped round with a large knife or a hatchet, so

as to be a rough fit, and pierced with a number of very small holes. The holes can be easily bored with an awl used in the ordinary way: or far more quickly with a drill and small bit (p. 10).

The slate should be rendered immovable on the top of the sand, by being fastened in some way round the edge, but so that it can be easily removed. Portland cement (p. 213) is perhaps the best fastener: three or four little bits can be put at intervals all round: and the rest of the space between the edge of the slate and the vessel, may be merely daubed over to fill it up. The cement will adhere to both slate and vessel, and can be broken when the slate has to be removed; or if there is any difficulty about it the slate itself can be broken, as it is very easy to replace it.

As the charcoal and sand will have to be occassionally taken out (p. 205) and must of course be kept separate, it may be better to put a round piece of slate pierced with a number of small holes between the lower sand and the charcoal, and another piece between the charcoal and the upper sand. These are easily made, and will last long; for they need not be fastened, and can never get broken, except by carelessness. The holes should be as small as possible, and placed very close together.

The cover.—There may be a cover of some sort: a piece of slate is the best and cleanest. But if the place where the filter stands be not very much exposed to dust, it is just as well to leave the top open, so as to give free access to the air.

The receiving vessel.—The filter proper is now finished; and it will be observed that no metal or wood has been used. Some arrangement must next be made to catch the water. Every complete filter is made up of two parts:—first the filter vessel with filtering materials as above: secondly, the receiving vessel to catch the filtered water. In the filters you buy, these two go together, the receiving

vessel being under the filter vessel, and generally covering it in completely, having also a cock at bottom from which to draw the water. This is of course the most convenient form.

To fix the filter vessel.—In our filter these two may be either separate or together: we shall first arrange to have them separate. Make a three legged stool—or any such like stand—the top formed of a piece of inch board. A round hole is cut in this board, so large that the filter will stand firmly in it, sinking into it nearly or altogether to the rim.

The bottom of the filter vessel must be far enough from the floor to admit of a vessel being placed under it; and the legs of the stool will have to be made long enough for this. A receiving vessel is kept continually under the filter, and the water is taken from it when wanted. This is the simplest form of filter: a section of it is represented in Fig. 73.

Filter vessel and receiving vessel combined.—A more convenient plan is to combine the two vessels, by fixing the filter vessel directly in the receiving vessel without the intervention of the stool. In this case a large pitcher or crock will answer best for the receiving vessel, with the mouth so wide that the filter vessel will sink nearly or altogether to the rim, so as to stand in it firmly.

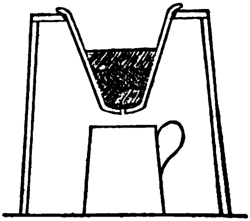


FIG. 73.

The cock.—A round hole about ½ an inch in diameter is to be bored in the side of the pitcher exactly at the bottom, into which a small brass or iron cock is to be inserted. The hole may be bored in the first instance with a large awl or with a drill, after which it can be enlarged with a rat-tail file (p. 18); I have seen a child eight years old bore a hole with a large awl through a piece of crockery ½

an inch thick in 8 minutes. If there is to be a cock, take care that the hole, when finished, be quite circular. Wind some soft thread firmly round the end of the cock and insert it pretty tightly with the hand: but do not hammer or the vessel may get broken. An earthenware cock which can be bought in china shops is better than a metallic one, but it will require a larger hole.

In the absence of a cock of any kind, a common wooden spigot, such as women use in milk vessels, will answer well enough—quite as well indeed as any cock, though not so convenient.

Now make a wooden stand like a little stool, and place the receiving vessel with the filter standing in it, so that the cock or spigot will project over the edge, and the filter is finished.

Taking a filter asunder for cleaning.—When a filter of any kind, whether bought or home made, is kept in continual use, both the sand and the charcoal will in time become quite loaded with the impurities they have taken from the water. When this happens, the filter will no longer purify the water, but on the contrary, the accumulated foulness may pass through and do mischief. It must therefore be cleaned at regular intervals, before the foulness has time to collect to excess—say once every four or five months. Remove the top slate and take out the sand and charcoal; after which wash the receiving vessel till it is perfectly clean.

Purifying the sand and charcoal.—Wash the sand thoroughly and boil it as at first: or what is better, get fresh sand. Heat the charcoal red hot as before: this burns and drives off all impurities, and it is now nearly as good and as ready to act as at first. This heating is in this case quite necessary.

After the filter has been cleaned in this manner four or five times, the charcoal should be renewed.

Filters should be easily taken asunder.—From all this it will appear that a filter should be so

constructed that it can be readily taken asunder to be cleaned. Whoever buys a filter (instead of making one) must be very careful to see that this is the case. Some filters are so made that they never can be taken asunder at all, and these are worse than useless. Others are intended to be taken asunder, but when one goes about doing so, it is found so hard a job that the whole filter has to be sent back to the shop to be cleaned.

Some few filters are made on more enlightened principles: without striking a blow they can be taken to pieces in a moment to be examined or cleaned: but these filters are very expensive. I have now before me the prospectus of one of the best of them, in which the price of a plain one, filtering 1 gallon per hour, is given, 15s.; 2 gallons per hour (about the size of filter for a family), £1 5s.; 3 gallons, £1 15s.

Advantage of self help.—As illustrating the great advantages of self help in such matters, I will here mention a circumstance that fell under my own observation. Some time ago a person bought a large filter for 45s. Among other impurities, the water to be filtered sometimes contained small active insects; and it was found that these often passed through the new filter, and used to be detected in the glasses at the dinner table.

After some time it became necessary to clean it; but although the prospectus stated that it could be easily taken asunder, there was such difficulty in doing so that the filter vessel got broken in the process, while the receiving vessel with its cock remained uninjured. Sending to the shop to inquire the price of the broken vessel, the purchaser was told he would have to pay 30s. for it—though it looked like a thing that might be made for 3s. or 4s. He declined to buy it, and determined to make one; and it was made under my superintendence.

He bought a flower pot for 1s. 3d. of the dimensions

given at page 200; and put into it the charcoal (2 lbs.) and sand exactly as described above. This was placed standing in the mouth of the uninjured receiving vessel, and the filter was complete. Thus for 2s. 3d. this gentleman had his filter better than it ever was—not permitting insects or impurities of any kind to pass through, and easily taken to pieces to be examined, cleaned, or renewed.

To make a pocket filter.—Every one who walks or drives long distances in summer knows the luxury of a good drink of cool water. In some parts of the country you will travel miles upon miles without meeting a spring well. You may come across streams: but few or none may be fit to drink from; and you can never be sure that you can get good water in the houses by the wayside.

A tourist should furnish himself with a pocket filter, which may be bought for about 3s. 6d., or made for a few pence. After what has been said the following directions will be easily intelligible with the aid of the diagram.

Get a piece of glass tube 5 inches long, and about ¾ inch in internal diameter. Cut two good corks to fit tightly into the two ends. Through each cork insert tightly a small bit of glass tube, like the tube used in babies' bottles. The three tubes can be bought for a few pence in a chemist's or druggist's shop. Now insert one of the corks (containing the tube) firmly into one end of the large glass tube. Down on it, in the tube, put a bit of sponge (A, fig. 74), thrust in through the large tube from the open end, and pressed pretty tightly on the cork. On this an inch of sand (B): and on this the charcoal (C) to fill the rest of the tube except leaving room for the other cork.

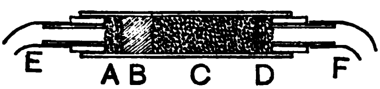


FIG. 74.

Now insert this other cork with another bit of sponge (D) between it and the charcoal. Fasten a bit of black vulcanised India rubber tube on each of the small glass tubes. At E and F are seen the ends of these tubes, which may be of any convenient length. On the end of the tube F insert a little mouthpiece of any kind. This completes the filter; and it will purify the water of any ordinary stream or pond. When you want to drink, drop the end of the tube E into the water and suck the mouthpiece.

The two corks must be moderately air-tight: if they are not, make them so with sealing wax varnish (p. 133). The sharp edges of the ends of the glass tubes can be rounded by being held in a gas jet or the flame of a spirit lamp, till the glass begins to melt: or they can be simply worn down on a whetstone.

It is to be observed that the India rubber tubes are not an essential part of the filter: they are a mere luxury to prevent the necessity of stooping. Without them the filter is much smaller for the pocket; but then the tourist will have to stoop or go on his knees for a drink.

This filter, must of course be occasionally opened, and the sand, charcoal, and sponge, and perhaps the corks, all changed.

A homely pocket filter.—I have seen an ingenious young friend extemporise a pocket filter for a long day's journey, from the tube of a penny popgun. He first burned the inside with a red hot iron, and then steeped it in water long enough to remove the flavour of the burnt wood. The two small tubes he made from the leg bones of a fowl: each was nearly two inches long, and they were washed carefully in the inside, first in soda and water, and afterwards in pure water, to remove all trace of loose animal matter. The rest of the construction was the same as described above.

This filter will answer very well for the occasion: but it should be taken asunder after a few days' use; then burn the inside of the tube again, wash the small tubes and corks, and put in fresh sponge, sand, and charcoal, and the filter will be as good as at first.

CHAPTER XIX.

HANDICRAFT OF VARIOUS KINDS.

Mounting Maps.

To mount a wall map.—Get a piece of linen somewhat larger than the map. Wet it, and while wet, stretch it tightly on a board or table, nailing it down with tacks all round the edges. Let it remain so till it is nearly dry.

Damp the map by sponging or sprinkling the back with clean water. While both linen and map are damp, spread *on both* a thin coating of flour paste made as directed at p. 142. The paste may be spread with a clean paint or glue brush, or in any other way found most convenient.

A paste which is finer and better for purposes like the present than that described at the page referred to may be made in the following way.

Take $\frac{1}{8}$ of an oz. of best gelatine or Russian glue, and put it into $\frac{1}{6}$ of a pint of water: cover it up and let it steep for a night. A penny tin is best for this purpose.

Get 1 oz. of the best arrowroot, and blend it in $\frac{1}{2}$ a glassful of water till it is a perfectly uniform paste without lumps—*it is most important that there be no lumps.* Pour gradually on this $\frac{1}{6}$ of a pint of water, stirring while pouring: it will form a milky liquid.

Now put the tin with the steeped glue on a gentle fire or over a spirit lamp (p. 219)—not adding any

more water—and keep stirring while heating: when it is quite melted, stir up the arrowroot liquid once more, and pour it very gradually into the tin, stirring all the time. Put the tin with this mixture on the fire or over the lamp, and boil for about 4 minutes, keeping it stirred continually. Then take it off and put it aside to cool. Before it is quite cold and while still liquid, put into it 2 teaspoonfuls of methylated spirit and 4 drops of carbolic acid, and mix up. This is the paste; it should be kept in a wide necked bottle. The spirit and the carbolic acid will preserve it from putrefaction: and to all intents and purposes it will last for ever. When cold it is a thick jelly. When wanted for use, liquify it by immersing the bottle in hot water—taking care not to let any water get in.*

Put down the pasted back of the map gently and smoothly on the pasted linen; and when down rub it with the side of the hand from the centre towards the edges all round. While rubbing, keep a sheet of paper between the hand and the map, and rub hard

* Wherever there is much weighing of small quantities, the amateur should have a little scales. A scales that will weigh as high as 1 lb. and as low as ⅛ of an oz., with a set of weights, will cost about 3s.

In many receipts you are told to mix things in complicated proportions—for instance 12 parts of A, 33 parts of B, and 47 parts of C. This seems at first sight a difficult matter. I have always done it very simply by employing shot—all of course of the same size. To take the above example:—put into one pan of the scales 12 grains of shot, and into the other pan as much of A as will balance it. So with the 33 parts of B, and the 47 parts of C: and you have the three proportions very accurately.

If you always keep the same shot, and register the number of grains that go to an oz. (or a lb., if the shot is large), any fraction of an oz. or of a lb. may be easily weighed. In this way you can easily *weigh* ⅕ of a pint (4 oz.) of water, and ⅛ of an oz. of glue, for the paste mentioned above.

In connexion with this, the reader will find it convenient to remember that a gallon of water weighs 10 lbs., a pint 20 oz., and a glass 2½ oz.

to smooth well and squeeze out superfluous paste at the sides.

When it has been made quite smooth and free from wrinkles, put some *clean* paper down on the face of the map—blotting paper is best; and down on this put boards or books, or anything flat, so as to cover the whole surface. Let it remain so for a day; then take off the covering, and let the map dry thoroughly—but do not dry it at a fire.

Cut it straight at the edges, and nail at top and bottom with $\frac{1}{4}$-inch tacks, neat laths, stained and varnished: or if the map is intended to be rolled up, put a roller at the bottom. When nailing, stretch a piece of tape all along, driving the tacks through it, so that it will lie between their heads and the map. Then supply rings and a cord in the usual way for hanging up. It is usual to bind the two edges of mounted maps with narrow coloured ribbon. After mounting, it may be varnished in the manner shown at page 133.

In this manner a print, a certificate, an address, &c., may be mounted and varnished, if printed or written on only one side of the page.

To mount a travelling map.—A travelling map is cut into squares so as to fold up for the pocket.

Suppose the paper on which the map is printed—measuring as far as the four marginal lines—is 24 inches from top to bottom and 20 inches wide. Here the length may be divided into 4 parts, and the width into 5 parts, making each square 6 inches by 4, which is a convenient size for the pocket.

Divide very exactly, with a compass, each of the two side lines into 4 equal parts, and each of the top and bottom lines into 5 equal parts. With a straight edge draw pencil lines from point to point, crossing each other: these will divide the map into squares of 6 inches by 4. With a sharp penknife, guided by a straight edge, cut out the squares along the lines—20 in all.

The linen is to be wetted, stretched, and tacked down to the table the same as for a wall map (p. 209). When it is nearly dry, mark on it with straight edge and pencil, a rectangular space somewhat larger than the whole map. On each of the two side lines measure off with a compass four lengths, each exceeding the length of each map-square by about $\frac{1}{8}$ of an inch. In like manner measure on the top and bottom lines five lengths, each exceeding by the same amount the width of the map-square.

Draw with the straight edge thin and decided pencil lines from point to point as before, dividing the linen into 20 squares, each of which will be $\frac{1}{8}$ of an inch larger each way than the map-squares.

The map is to be pasted on, square after square. Begin at the top left hand square. Spread the paste thinly and evenly on linen and map-square; and place the square down very carefully, so that the pencil lines on the linen will be just outside the map-square all round, and equally distant from the sides. Press and rub it well down with the side of the hand, with blotting paper between.

Place all the map-squares in their proper positions, in the same manner. When any paste is squeezed out between the squares, wipe it up carefully with blotting paper.

When all the squares are pasted down, place books as before, with a sheet of paper between; and do not use the map till it is perfectly dry. When it is dry examine all the corners, and if it is found that some have not caught, touch them with paste again, and leave them under weights for another day. It will now fold up 6 inches by 4; and as there are narrow spaces of linen between the squares, it will fold without either strain or crease.

If the map is small and thin, the spaces may be less than $\frac{1}{8}$ of an inch: if it is large, with many squares, it may be necessary to have more space. A travelling map should not be varnished.

It is usual to keep a travelling map like this in a cover or case. Get a book cover the proper size, and paste the back of the left hand top square of the map (or the left hand square next the top) to the inside of one of the sides of the cover. The whole map will then fold up within the cover. The map should be always folded in the same way.

Cements.

Though plastering is not a business that an amateur will likely have much to do with, yet everyone ought to know how to handle and apply the most common kinds of cement. They are cheap for small jobs; easily managed by anyone accustomed to a little handicraft; and very often extremely useful about a homestead.

Portland Cement.—Portland cement is three or four times stronger than Roman, and of course much more useful and serviceable. It is a heavy dry powder: the best kind is of a bluish grey colour; but inferior kinds are brown, being adulterated with clay. The best Portland cement is £2 5s. or £2 10s. a ton. It is usually sold in bags, 10 to the ton; price from 4s. 6d. to 5s. a bag; and for those who do not want a large quantity, this is a convenient way to buy it. For very small jobs it may be bought for 6d. a stone—each stone in a paper bag. Not more than is wanted for the occasion should be bought; and if any remains over it should be kept in a dry place. If it get any wet or damp it will *set*, turning into hard lumps, which are quite useless. But if there is no damp it will keep good for any length of time.

When Portland cement is mixed up with water like mortar, and left to itself, it begins to *set* or grow hard in a few minutes; and it will ultimately become quite as hard as a stone. The best Portland cement will not have completely set till at the end of about three weeks: but inferor kinds, which are adulterated with clay, and which possess neither the hardness

nor the strength of pure cement, will set in a much shorter time.

Pure Cement.—For very small jobs, Portland cement may be used pure. Put as much as is wanted into a dish or on a board: wet it and mix it up till it forms a thick paste. Once it has come to such a consistency as to be easily worked do not wet it any more: for the thicker the paste—or in other words the less the water used—the harder the cement will become. Mix the water cautiously lest there be two much: but if this happens, put in a little dry cement.

This cement may be used to fill up the openings between stonework to make them water tight; as for instance the joinings in the steps leading to a door, or the joints of a stone cistern; or it will make-good fractures and faults in stonework. In all cases wet the spot before laying on the cement. A middle sized trowel for this sort of work will cost 1s.

Gauged cement.—For larger jobs, such as cementing the outside face of a wall, cement is mixed—or *gauged* as workmen say—with sand, which should be washed before mixing. Put some of the sand into a large tub, and fill up with water: stir up the sand with a shovel, turning it over and over in the water, and then let it rest. The dirt will be washed towards the bottom, and the washed sand can be then taken from the top. If the sand be not washed free of clay, the cement will be weak.

The sand should be very fine, and in order to make it so it must be sifted through some sort of sieve. Fine sand is more easily worked than coarse, and makes smoother work: but in other respects, it is not better than coarse sand, which makes quite as strong a cement. One part of pure cement gauged with three parts of sand will make a very strong cement. This is the usual proportion where good work is wanted: and when cement so made is fully set, it will be as hard as rock. It will moreover retain its hardness under water, as well as in the

open air. In inferior work the cement is often gauged with 6 or 8 times its bulk of sand.

No more water should be used than is necessary to make the cement easily worked: for like pure cement, the less it is wetted the harder it will be. It should be made in small quantities at a time, and used up immediately; for it quickly begins to set. When any that remains over has set, it may be thrown away as useless. Once the cement that has been used up has begun to set it should not be disturbed: or, if this is necessary, the part disturbed should be cleared out and fresh cement put in. The spot in which cement is to be put should be sprinkled with water, otherwise the cement will not catch.

If the outside of a wall be coated with good cement, no damp can ever get through. In order to do this, all old plaster must be knocked off, and the stones or bricks laid bare. The surface must be gone over twice: in other words there must be two coats; and tradesmen sometimes give three. The use of the first coat is merely to make the cement take to the wall. It is *scratched in*, as workmen say: that is, put in roughly and worked closely into all the hollows and crannies with the trowel. Each spot must be sprinkled with water (with a whitewash brush) before laying on the cement, otherwise it will not stick. When this first coat has grown pretty hard—i.e. after the lapse of four or five hours, or a whole night—the other coat is applied. Here it will scarcely be necessary to sprinkle the surface with water, for it is moist enough already. This being the last coat, must be made as smooth as possible. When smoothing, keep sprinkling the surface with water, which will make the cement more easily worked. It is usual, before the cement has grown quite hard, to mark it out in squares to imitate stonework, with the point of the trowel directed by a straight edge.

Cementing should not be carried on in frost; for frost makes the cement worthless, so that it will soon

fall off. But if there are light night frosts which do not continue during the day, it may be put up in the day time, and it will be hard enough to resist the light frost of night.

A vessel in which cement has been used should be washed out immediately after the job is done; if the cement be allowed to set it will be almost impossible to remove it without breaking the vessel. It is better to gauge cement on a large board or in a vessel; or, if mixed on the ground, the spot should be hard and quite clean, lest clay might get mixed in.

Concrete.—Concrete consists of a mixture of some cementing material with water, sand, and coarse gravel. The coarse gravel may be broken stones or bricks, bits of earthenware, or any other coarse rubbish that may be at hand—except clay or anything of that nature. And it will be all the better if there are pretty large stones like road metal mixed up with it. Sharp angular gravel or stones are best; for round smooth stones do not give a good hold. When all these materials are wetted and well mixed up, the cement and sand form a mortar by which the coarser materials are cemented together into a mass which will become as hard and solid as if it were one piece of rock. The coarse materials are called by workmen the *aggregate*, and the mortar that binds them the *matrix*.

To make concrete.—The proportions may be 1 of Portland cement, 2 of sand, and about 5 of aggregate; or if the aggregate is a mixture of coarse and fine gravel, in which there is already enough of sand, 1 of cement to 7 of aggregate. When these are thrown together into a heap, they should be turned over 2 or 3 times while dry, to mix them intimately. Then wet the heap from the rose of a watering pot—not by emptying a vessel of water on it suddenly, which would wash away the concrete. It is not to be wetted more than is necessary to mix the materials well. After wetting, turn it over again two or three

times, and it is ready for use. Once made it should be immediately put into its place, for it sets very soon. No clay or dirt of any kind should be let get into the mixture: any substance of this kind will weaken the concrete.

In making concrete, lime is sometimes used instead of cement, or a mixture of the two, but the concrete is never so hard as with pure cement.

Uses of concrete.—Concrete is coming into use more and more every year: very often the lower parts of the walls of houses, and sometimes the entire walls, are built of it. If a layer of concrete be put under the foundations of walls, or under the floor of a house, it will be impossible for damp ever to find its way up. It is very usual to build the foundations of walls, as far as the surface of the ground, of concrete, an excellent plan which will ensure dryness. Concrete is also often used to make walks, garden steps, &c. Whenever any structure over ground, such as a series of steps, a low wall, &c., is made of concrete, there must be some arrangement to hold it in its place till it dries; which is generally done with boards.

Plaster of Paris is a white powder, which, when wetted, quickly sets or hardens like Portland cement —much more quickly indeed. It is not so strong as Portland cement, and will not resist the weather long: but it is much used for plastering the interior of houses, the last coat being generally a *putty* made by mixing one part of plaster of Paris with three or four times its own bulk of lime. This is what is called *gauged stuff* to distinguish it from putty made of pure lime. This gauged stuff is very useful for mending cracks or flaws in plaster of paris ornaments, and in the plaster and cornices of rooms. As it sets very quickly, it must be used within half an hour after it is made. Whenever it is about to be applied, wet the spot, else the plaster will not stick.

Only as much as is wanted for the occasion should be made, as any that remains over will be useless once it sets.

Price.—Plaster of Paris is 40s. a ton; and can be bought in small quantities for 6d. a stone. Like Portland cement it must be kept in a dry place, and for the same reason.

Lime putty.—To make lime putty, either to be used pure, or gauged with plaster of Paris or other cement. Put the lime into a tub, or if a large quantity is wanted, into a cup-like hollow made in the middle of a heap of sand. Slake it, after which throw in water enough to cover it completely. Stir it up from the bottom: after which let it subside. Then either draw off the superfluous water, or let it evaporate. The coarse sediment—which is useless—will be found to have gone to the bottom, and the pure white lime putty remains on top.

Cement for china.—Plain shellac (not shellac varnish) forms one of the best cements for broken china: as much can be got for a penny as will mend a score of broken articles. Suppose a plate is broken in two, without the edges being injured. Heat the broken edge of one of the pieces by holding it over a spirit lamp, and drawing it backwards and forwards its whole length through the flame. When it is hot enough to melt the shellac, rub the latter slowly along the edge: it will leave a thin coating on the broken surface. Do the same with the other piece.

Now take the two pieces, one in each hand, and draw the two edges two or three times through the flame to melt the shellac. When it is melted along the whole length of each edge, put the two edges together quickly, taking great care that they be exactly fitted: keep them pressed together for two or three minutes till the shellac is cold; and the work is done. Care must be taken not to heat the shellac to excess, which would burn it black and make it useless.

Any broken piece of china—a plate, a cup, a saucer, &c.—can be cemented in this way. It calls for some dexterity and steadiness of hand; but if it be well done, the mended article will as soon break any where else as at the joining. It will moreover bear any ordinary amount of immersion in cold water; but immersion in hot water will gradually melt it.

A spirit lamp is a most useful article, and every amateur should have one. A fair sized lamp may be bought for 1s., and the methylated spirit that burns in it costs 8d. a pint.

If however you have the proper materials, it is easy to make a lamp without any expense, that will be quite as good as those you buy.

Get a little bottle, wide and short in shape—a common glass ink bottle, will do—and fit it with a cork. Fit into the cork a bit of thin glass tube (like the tube of a baby's bottle) about 1½ inch long—passing it quite through. The hole may be bored in the cork with a slender sharp penknife blade and smoothed with a hot iron. Pass some cotton wick through the tube—as much as will fill it; and having nearly filled the bottle with spirit, insert the cork. The glass tube should now rise half an inch or a little more over the cork, and the wick should project a little above the glass. If the wick is fresh, wet it with spirit before lighting it. The size of the blaze can be regulated by raising or lowering the wick with a pin.

If the glass tube does not rise far enough above the cork, the whole neck of the bottle is liable to take fire. But if this happens it is no harm: merely blow it out.

When this lamp is not in use, keep a thimble—or a cork cut hollow—over the wick: otherwise the spirit will quickly evaporate through the wick.

Transparent cement for china.—When broken china is cemented with shellac as described in the last article, the joinings are plainly marked: but if the

following cement be employed, the joinings will be almost invisible. Put 1 oz of the best gelatine into a small wide necked bottle, and pour on it as much whiskey as will well cover it: let it stand for a day or two. The gelatine is now soft; and in order to dissolve it, immerse the lower part of the bottle in boiling water—taking care that none get in. Stir it repeatedly with a bit of stick, and keep the bottle in the water till the gelatine is completely dissolved. When this is the case, remove the bottle, and the cement is ready. When cold it is very stiff like cold glue in a glue pot.

When wanting to use it, place the bottle in hot water till the cement is liquid. When it is liquified as much as it can be it ought to be quite free: if it is still stiff and stringy, put a little whiskey to it and mix up: then again immerse it in boiling water till it is liquid. It is a mistake to think that the cement is the stronger by being very thick.

When a broken article is to be mended with this cement, place the pieces near a fire or in an oven, till they are moderately hot—just so hot that you can handle them without inconvenience. Then, the cement having been liquified, put a coating along the two broken edges with a shaving—or any such like. Put the edges together and press tightly, so as to squeeze out as much as possible of the cement—for the thinner the layer the stronger the joint. Keep the edges together till they are cold: after which let the article lie by in a warm place for 48 hours: the joint is then made. If the shape of the article admits of it, it will be better, after cementing, to tie it tightly with a cord, taking care not to disturb the joint.

If there is a third broken piece, it can be put into its place in the same way—*at the end of the* 48 *hours;* and so on for any number of pieces.

This is an excellent cement for china vessels, or china ornaments; but though it will bear the ordinary

amount of washing, it will not bear continual immersion in water like shellac cement.

Another transparent cement.—If acetic acid be used with gelatine instead of whiskey, as in the last example, another valuable cement will be formed: ask at the druggist's for *commercial acetic acid* (not *glacial* acetic acid); it is about 1d. an oz. The mode of preparing this cement, and the manner of using it are the very same as described for the last.

This is perhaps the most generally useful of all ordinary cements. It will stick almost any two things together—china, glass, bone, ivory, horn, wood, leather (if not oily), marble (as in broken statuary), stone and minerals of almost every kind, plaster of Paris ornaments, &c., &c.; and it may be used to stick bits of cork together in making cork models, such as castles, houses, &c.

China and glass mended with this will bear ordinary washing, but not continuous steeping in water. In cold weather it may take three or four days to harden. The less porous the object is, the longer it will take to dry; it takes longest of all with glass.

If there is the least grease on the surface to be joined, the cement will not catch: but grease may be removed by washing with benzine. (Benzine—not benzoline, which is a very different thing—is a sort of spirit, much used for cleaning gloves, removing grease, oil stains, &c. It is moderately cheap; a couple of pennyworths will be enough for many jobs such as described here).

Cement for fastening knives and forks in their handles.—Take three parts of common rosin, one of beeswax, and one of fine brick dust (made by powdering, or scraping, or filing, a piece of good sound brick). Melt the rosin and the beeswax, and mix with them the brick dust.

Fill the opening in the handle with small bits of this mixture. Heat the shank of the knife or fork

till it is nearly red, and press it home: holding the handle with paper wrapped round it—or better in a vice. Put it aside to cool, and the work is done. It is as well to remark that knives and forks should never be put into hot water, which will be pretty sure to crack the handles, and will loosen any cement.

To fasten cloth on wood.—Sometimes one has occasion to fasten velvet, American cloth, &c. to wood. For example, a frame for a photograph, or a stand for a watch, may be made of wood and covered with velvet, which looks very pretty. The best cement for this is thick glue: spread it evenly on the wood with a brush, and put down the cloth, rubbing it all over, or holding it for a few moments in certain spots to make it stick. If the glue be thin, it will make its way through the cloth and spoil it; and besides the cloth will not stick, the glue being absorbed. The cloth must be placed at once very exactly in its proper position, so that it will not be necessary to raise and replace it. Lest the glue may be too thin, it will be better to make trial at first on a waste bit of cloth.

The Graph.

Nature and uses.—Of the many contrivances for multiplying copies of writing, the graph or polygraph is the simplest, the cheapest, and the most easily made. It is now beginning to be much used in Government offices; and it is most useful in schools for the multiplication of examination papers and other such purposes.

To make a graph.—*The tray.* Get a sheet of tin (p. 172) 2 inches longer and broader than the largest sheet of paper to be used. Turn up sharply, at right angles, about ½ an inch of the edge all round, so as to form a shallow rectangular

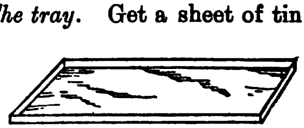


FIG. 75.

tray or dish, ½ an inch deep, as seen in fig. 75. In order to make the corners fit, a bit must be cut out of each, after which the edges are to be soldered. But if soldering is not within reach, the corners may be made tight with a bit of white or red lead. By a little management too they may be folded with a pliers without cutting.

The graph composition.—Put 4 oz. of gelatine into a wide necked bottle, and pour on it 15 oz. of water (i.e., ¾ of a pint: see p. 210, note); cork it up and let it stand for 24 hours to soften the gelatine. Then immerse the lower part of the bottle in boiling water, stirring it till the gelatine is completely dissolved. Remove the bottle from the boiling water; and while it is still hot pour in 15 oz. of glycerine. The glycerine being heavy will fall to the bottom, so that the contents must be well stirred (with a bit of stick) in order to mix them thoroughly. Then add 5 drops of carbolic acid, and stir once more.

While the mixture is still hot and liquid, pour it very gently—with as little agitation as possible—into the tray, which must of course be lying horizontal; it should form a layer about ⅜ inch thick. If there are any bubbles, they must be removed, which may be done by lifting them out bodily with a spoon or with the corner of a piece of stiff paper; or by drawing them one by one (if they are few) to the sides with the head of a large pin.

When the composition is cold it will be very like strong jelly, having a beautiful elastic smooth surface. The making of the graph is then finished; but it will not be fit for working till after the lapse of about 3 days. The quantity of composition here made will be enough for a large graph, foolscap size. The quantities must be weighed very accurately, for any departure might spoil the composition and lead to failure.

The greater the proportion of gelatine the harder and drier the composition will be: the more the

glycerine and water the softer. If the composition be too hard, it will give very faint copies : if too soft the paper will stick too closely and will bring away some of the surface. If through any error, the composition is made either too hard or too soft, the remedy is obvious ; add more gelatine to harden ; more water and glycerine to soften. But care must be taken not to add in excess ; for a small addition of either the one or the other will make a decided change.

Several other receipts for graph composition are given in books; but the above will be found as simple, and probably as good as any other. I have now before me a graph made in this way, which works very satisfactorily.

Graph ink.—The ink required is what is called *aniline ink*. It is best to buy it if it can be had : ask for *graph ink* of the colour wanting. If it cannot be got to buy, it may be made in this way. Get say, $\frac{1}{4}$ of an oz. of violet aniline, which is sold by druggists (1s. 6d. an oz.) in the form of a coarse powder, something like blasting powder. This $\frac{1}{4}$ of an oz. will make a plentiful supply of ink.

Put a little of the aniline into a phial, and pour on it about twice its own bulk of methylated spirit. It is necessary that the aniline be dissolved in the spirit, which is rather a tedious business, and requires patience. Place the phial, corked up, before a fire where it will be well heated; let it remain so for a day or two—keeping it heated all through—and shake it repeatedly. When at last the aniline, or a good part of it, is dissolved, put in a few drops of gum to give the ink body, and shake the phial. Then add water enough to thin it : always remembering that graph ink must be considerably thicker than ordinary ink.

There are various colours of aniline, with any one of which ink may be made ; but there is no black. The nearest aniline colour to black is violet, which is therefore the colour most generally used, as it gives

the most distinct copies. But red is also much used; and any piece of writing may be copied in violet, or in red, or in both combined.

Judson's violet dye answers fairly well for ink; but it will not give more than 25 or 30 copies. It is sold in small bottles—6d. each. To make ink from it, add about half its own bulk of gum, after which thin with water. These dyes are also sold as dry powders in penny packets. To make ink of the powder, dissolve a packet in hot water, and add some gum.

To copy with the graph.—Write with graph ink on one side of a leaf of *hard well-glazed paper*; soft porous paper will not answer. A broad pointed pen should be used, and the writing should be heavy and well inked, with no fine hair strokes. Leave it to dry, using no blotting paper. When it is dry turn it, face down, on the graph. Lay down one edge first, and then put down all the rest, stretching gently to avoid wrinkles, and taking great care not to displace any part once it has touched the graph. When it is down, press and rub it all over with a loose handkerchief or a clean rag, till it is in complete contact. But do not rub it with the hand or subject it to any heavy pressure, which would be sure to spread and blot the ink underneath.

Let it remain so for 10 minutes. Then beginning at one corner, lift it gently off: it will come away quite easily, and will leave on the surface of the graph a complete impression of the writing reversed.

The reason of using hard glazed paper will now be seen: viz., in order that the ink may not sink into it, but may remain on the surface, so as to be available for transfer to the graph surface. But any paper, whether glazed or not, may be used to take copies.

Now take one of the sheets intended for the copies, and turn it down on the graph. Rub it well with the side of the hand till it is in perfect contact; there is now no danger that the ink will spread by pressure.

Let it lie for a few seconds and then take it off; it will bring away on its face an exact copy of the original writing. Do the same with another sheet, and it will take another copy: and so on. In this manner from 40 to 80 copies may be taken according to the quality of the graph and the ink.

Before using a graph it will be useful to breathe on it, or moisten it slightly in any way; but the moisture must be immediately wiped off so as to remove every trace; and the graph ought to be let rest for a few minutes before using it. This moistening mellows the surface and tends to improve the working.

When the copying is finished, wash the surface of the graph lightly with a sponge and hot water, and keep washing till the reversed writing is completely removed. This must be done immediately after the last impression has been taken: for the ink sinks rapidly into the substance of the composition; and if it get time to sink it will spoil the graph. When it has been washed, it is then ready to take any other piece of writing.

It will sometimes happen that the first four or five copies are indistinct, and the subsequent ones good. When many copies have been taken they begin to grow indistinct, which is an indication that the action of the original impression is nearly exhausted. Coming towards the end consequently it will be necessary to let the paper lie longer than for the earlier copies. When the copies begin to grow indistinct the paper may be slightly moistened before laying it on, which will increase the distinctness of the copy.

To renew a graph.—After a graph has been for some time in use, its surface becomes a little rough by the repeated washings, and it will then give rough copies. Or the graph may grow dry by long keeping, or will gather brown spots which will interfere with its working. When one or more of those things happen, the composition must be removed from the

tray, re-melted, and replaced. It will then be as good as when first made. To remove it from the tray, lift one corner with a knife: then take hold of this loose corner and pull the composition gently and gradually: it will come away without breaking, much in the same way that a leaf of paper comes away from the graph itself. If brown spots have gathered cut them out before re melting.

If a graph be small—the size of note paper for example—mere roughness of the surface can be remedied without removing the composition from the tray: place the graph *lying level* in the oven, or over a gentle fire on a gridiron, and leave it so till the composition melts. Then remove the tray, and let it cool, and the surface will be as smooth as at first. But this cannot easily be done with a large graph.

Few persons succeed in the first attempt at making a graph, so that a beginner must not be discouraged by one or two failures. If the graph does not work satisfactorily, both the composition and the ink should be looked to; for the failure may be due to either.

Cost.—A graph ready made, foolscap size (about 14 inches by 9), which may be got in stationers' shops, will cost 16s. The composition is sold separately in canisters, price 2s. 6d. each, two of which will be enough to fill a foolscap-size graph. Suppose the purchaser to buy the composition and to make the tray, the tin for which will cost 3d., the total cost in this case will be 5s. 3d. But if he make the whole graph in the manner described, the cost will be:—15 oz. of glycerine (1s. 4d. a lb.), 1s. 3d.; 4 oz. of gelatine, 1s.; tray, 3d.: total, 2s. 6d. A small graph, letter paper size, which will cost about 5s. may be made for about eightpence.

THE END.

APPENDIX.

Programme for National Teachers for certificates of competency to teach and earn Results Fees in Handicraft.

To be acquainted with the construction, peculiarities, and uses of the principal tools used in carpentry and joinery, and in any other handicrafts selected by the candidate.

To be acquainted with the various kinds of nails and screws in common use, and to be expert in driving them.

To be acquainted with the chief technical terms used in the handicrafts selected by the candidate. To be prepared to show intelligence and practical expertness in any five of the following (at the choice of the candidate) :—

1. To prepare and use glue. To plane up the edges of two boards, and glue them together. To make a tenon and mortise joint. To make a simple dovetail joint.
2. To dowel two boards together, and strengthen them with glue. To rabbet and bead-mould two boards, and join them together, using ledges and either screws or nails.
3. To plane up, rabbet, and mitre-joint four pieces of wood, so as to form a frame for a tablet or picture.
4. To be acquainted with the several kinds of locks in common use, with their peculiarities. To put on a lock, using, if necessary, a board to represent door, box, &c. To take off an old lock. To take a lock asunder and put it together again.
5. To be acquainted with the several kinds of hinges in common use. To put on a hinge of any ordinary shape, using, if necessary, boards to represent door and jamb, box and lid, &c.
6. To be acquainted with the principal ways of scarfing and splicing. To splice any such thing as a broken broom-handle, rake handle, pointer, &c., securing the joint with screws, or copper wire, or waxed cord. To make a half-lap joint.
7. To cut out and make a rail for a clothes rack, screwing on the hooks. To be acquainted with the different kinds of hooks. To know how to fasten up a rail to a wall by simple plaster—nailing as well as by plugging. To understand the construction of several forms of paling.
8. To know the composition of hard and soft putty. To be able to cut glass, using either a diamond or an American glass-cutter. To hack out a broken pane and put in a new one.
9. To have some knowledge of the ingredients of the most important paints. To mix paint of any ordinary colour, and to paint with it. To understand staining. To prepare a board for staining; to stain, size, and varnish it.
10. To understand the nature of soldering. To tin a soldering iron. To do any plain piece of soldering, such as fixing in the loose handle of a tin vessel, soldering together two pieces of tin, brass, &c. To do plain riveting.
11. To mount a map with linen, roller, &c. To mount a travelling map for the pocket. To know how to make paste.
12. To mend a break in any common article of furniture—a chair, a gate, a school-desk, &c. To make any small simple article—a stool, a little box for pencils, a nail box, a drawing board, &c.

INDEX.

M. H. Gill & Son, Printers, Dublin.